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FEBRUARY 2021

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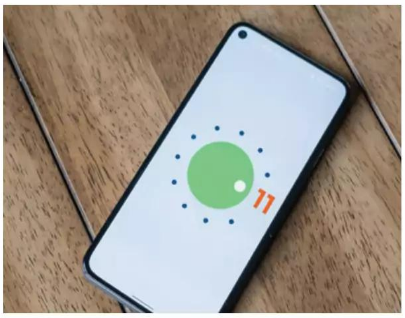

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PCWorld
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CES
2021

CES 2021: The most intriguing and innovative PC hardware

CES 2021 was virtual, but the parade of PC hardware went on. **BY PCWORLD STAFF**

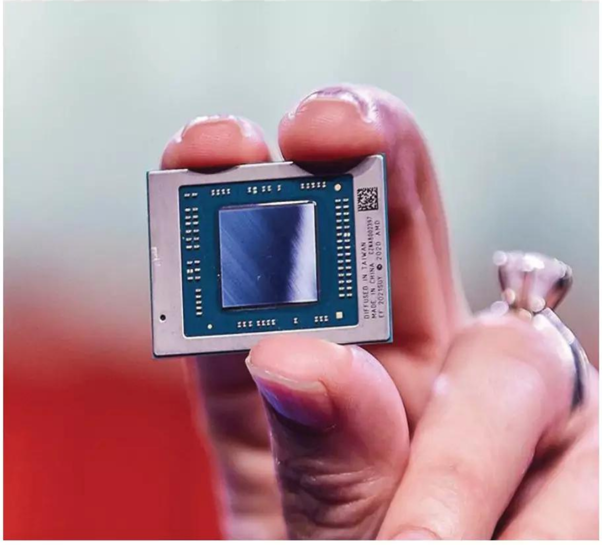
CES 2021 was virtual, but the parade of PC hardware went on regardless. Big names AMD, Intel, and Nvidia all made splashy announcements, and PC manufacturers followed in their wake with new products, many coming soon.

No time to sift through all our CES coverage (go.pcworld.com/cesc)? No problem! Read on for our Best of CES picks—the most intriguing and innovative products we saw.

AMD RYZEN 5000 MOBILE

Last year you couldn't find a high-end gaming laptop with a Ryzen CPU in it to save your life. This year the tables are turning, with probably a dozen different designs announced or in the works.

IMAGE: ROB SCHULTZ



That should confirm the confidence laptop makers have in AMD's Ryzen 5000 Mobile (go.pcworld.com/rmob), based on the award-winning Zen 3-based Ryzen 5000 desktop chip. While we don't have independent testing yet, we expect it to dominate in multi-core performance and take the lead in single-core performance. —*Gordon Mah Ung*

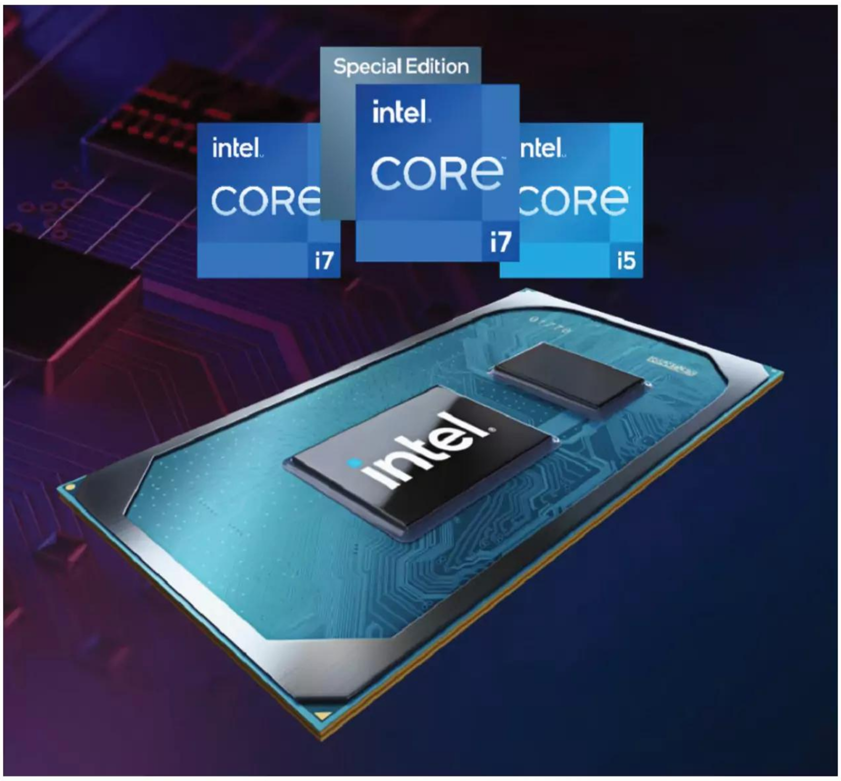
INTEL TIGER LAKE H35

Intel's 11th-gen Tiger Lake CPU has been a legitimate ray of light in a Ryzen-clouded sky. Featuring improved efficiency, high clocks, and leading integrated graphics, we'd honestly say Tiger Lake was the best CPU for what people do in a small laptop.

With Tiger Lake H35, we think Intel may have found a sweet spot, promising up to 5GHz clock speeds in laptops that aren't quite thin-and-light but weigh far less than your typical gaming laptop. It probably won't win any races with AMD's new Ryzen 5000, but it's likely to offer lots of speed for what most people do. —*Gordon Mah Ung*

NVIDIA GEFORCE RTX 3060

Among the many goodies Nvidia announced at CES, the $329 GeForce RTX 3060 desktop graphics card (go.pcworld.com/329g) deserves to be highlighted because it gives mainstream gamers a next-gen graphics option that doesn't require a second mortgage (although spiking custom card



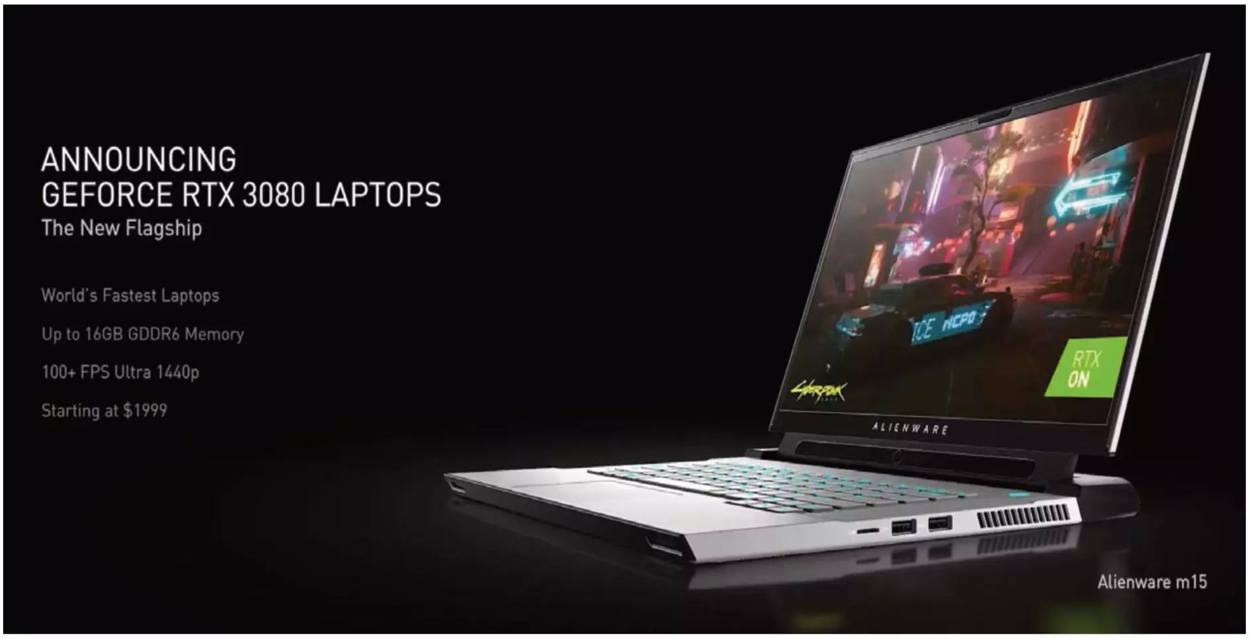
GEFORCE RTX

prices [go.pcworld.com/spke] won't help).

Better yet, the GeForce RTX 3060 includes an ample 12GB of GDDR6 memory—more than any other graphics card in the Ampere lineup shy of the flagship RTX 3090. (You can thank AMD's Radeon cards [go.pcworld.com/rdgp] for forcing Nvidia to be more generous.) Either way, the affordable GeForce RTX 3060 should be a hit when it launches in late February. *—Brad Chacos*

NVIDIA GEFORCE RTX 3000 MOBILE

Nvidia's mobile GPUs have never been challenged, and the company keeps innovating. Just four months after its desktop 30-series chips launched, we have the mobile version. We saw it in essentially every single gaming laptop released at CES, and it should give us performance and efficiency we've never seen before in the mobile space. It's no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FLOW
X13
ROG FLOW

surprise, but the GeForce RTX 30-series stands up as clearly one of the best technologies at CES. *—Gordon Mah Ung*

ASUS ROG FLOW X13

The Asus ROG Flow X13 (go.pcworld.com/fx13) offers a unique take on RTX 30-series laptops coming out of CES. Rather than trying to cram a powerful GPU into its slender chassis, Asus opted for a slender laptop paired with a semi-proprietary external GPU called the XG Mobile.

This offers a win-win-win for laptop gamers. When not gaming, the ROG Flow and its GTX 1650 weighs 2.8 pounds and should be easy to carry around for work purposes. But when you want to game, you plug in the 2.2-pound XG Mobile and enjoy the full performance of a mobile RTX 3080 without any concerns about thermal throttling. *—Adam Patrick Murray*

HP ELITE DRAGONFLY MAX

The HP Elite Dragonfly Max (go.pcworld.com/drmx) is a corporate laptop made for the times we live in, when everyone is working remotely and staring into their webcams for hours on end in videoconferences. For remote work, the laptop weighs about 2.5 pounds, and it sports a 360-degree hinge for versatility as you move your workspace from desk to kitchen counter to sofa to rug. For videoconferencing, it offers high-res cameras, extra mics, and AI-enhanced audio features.

As a corporate laptop, it's equipped with extra security and performance features, plus an integrated Tile module for trackability. It's also one of the coolest-looking laptops we've seen, with a choice of iridescent blue or black shell, and gorgeous display options.

LENOVO LEGION 7

The Legion 7 has a lot going for it simply with its Zen 3-based Ryzen 9 and GeForce RTX 30-series graphics, wrapped in a 16-inch laptop with a QHD-resolution (2560x1600), 16:10 display.

But what really helped the Legion 7 stand out among all the other Legion gaming laptops Lenovo announced (go.pcworld.com/lnan) is its RGB lighting, which has now

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spread beyond the keyboard and chassis to the laptop's exhaust vents. How cool is that? —*Melissa Riofrio*

MSI STEALTH 15M

With a quad-core Tiger Lake H35 and a GeForce RTX 3060 Max-Q GPU, the 3.7-pound MSI Stealth 15M (go.pcworld.com/st15) isn't going to win any drag races against laptops with more cores or fatter GPUs. But for a lot of us who just want the right amount of CPU performance and GPU performance, MSI's Stealth 15M is on our short list. —*Gordon Mah Ung*

RAZER BLADE 15 AND RAZER BLADE PRO 17

Many, many gaming notebooks will roll out featuring Nvidia's latest 30-series mobile GPUs, the Razer Blade 15 and Razer Blade Pro 17 (go.pcworld.com/b157) among them. And while Razer's promotional images of both look amazing, it's the sheer variety of display options that catch our eye. Razer allows customers to choose from 1080p, 1440p, and 4K, all at high refresh rates. The sweet spot? A 165Hz, 1440p display option paired with a GeForce RTX 3070. Count us in. —*Mark Hachman*

ACER PREDATOR XB273U NX MONITOR

Display technology rocked at CES 2021: We saw the first wave of (pricey) HDMI 2.1 monitors, the rise of 1440p screens on notebooks, and ultra-fast refresh rates becoming the norm on gaming laptops. The highlight for me was Acer's Predator XB273U NX (go.pcworld.com/x27u). Its 1440p resolution is PC gaming's sweet spot right now, offering a tangible visual upgrade over 1080p without requiring a $500-plus graphics card to power it. You may still want a

potent GPU for this monitor, however, because its refresh rate is a blistering 265Hz with a mere 0.5-second grey-to-grey response time. It's fast.

It's also high-quality, covering 95 percent of the DCI-P3 color spectrum, with an "HDR capable" panel that's TÜV Rheinland Eyesafe (go.pcworld.com/1sfe)-certified to emit less blue light than standard LCDs. Maybe that'll help you get to sleep more quickly after a late-night gaming session.

The cherry on top is that this is a G-Sync Esports panel, which means it includes Nvidia's awesome Reflex Latency Analyzer (see page 75) to help you fine-tune your rig or your games for maximum responsiveness. It's an essential tool if you're an esports pro, where every millisecond can make the difference between victory or defeat.

All that cutting-edge technology doesn't come cheap: The Acer Predator XB273U NX will cost $1,100 when it hits the streets in May. —*Brad Chacos*

RAZER 'PROJECT HAZEL' N95 MASK

Given the response that Razer's "Project Hazel" N95 mask (go.pcworld.com/phzl) received, this concept (which may or may not be produced) was the unexpected star of the show. It's a potent combination of sanitation (N95 filters and a self-sanitizing case!) utility (a transparent face mask and voice amplifier) and style (RGB!!), in a product category being worn by pretty much everyone in the country. —*Mark Hachman*.

INTRODUCING AT CES 2021

AMD RYZEN™ 5000 SERIES
MOBILE PROCESSORS

THE ULTIMATE BLEND OF PERFORMANCE AND EFFICIENCY

ULTIMATE PERFORMANCE
"Zen 3" Mobile
Processor in 7nm

INCREDIBLE EFFICIENCY
Leading Battery Life
For x86 Notebooks

UNMATCHED FLEXIBILITY
The **Only** 8-Core x86 CPU
for Ultrathin Laptops

AMD's laptop resurgence continues with Ryzen 5000 Mobile processors

Two straight generations of Zen processors have made inroads into Intel's market share in laptops. Can the Ryzen 5000 Mobile and Zen 3 continue the trend? **BY MARK HACHMAN**

AMD officially launched its Ryzen 5000 Mobile processors at CES 2021 in January, hoping to continue what it's accomplished on the desktop (go.pcworld.com/acdk): bring its powerful Zen 3 architecture to bear and oust Intel's Core i9 as the best gaming CPU. The unexpected bonus AMD adds is a renewed focus on battery life, potentially solving a noted weakness in Ryzen-powered laptops.

AMD chief executive Lisa Su ushered in the new lineup of mobile chips as part of her keynote address at CES 2021, now held virtually rather than in Las Vegas. Su didn't announce any new GPUs, but did say that the AMD RDNA 2 GPU architecture (go.pcworld.com/rdna) found within the RX6800 and similar chips will arrive in mobile GPUs in the first half of 2021, along with "mainstream" desktop graphics cards. She showed off a reference notebook running *Dirt 5* at 1440p

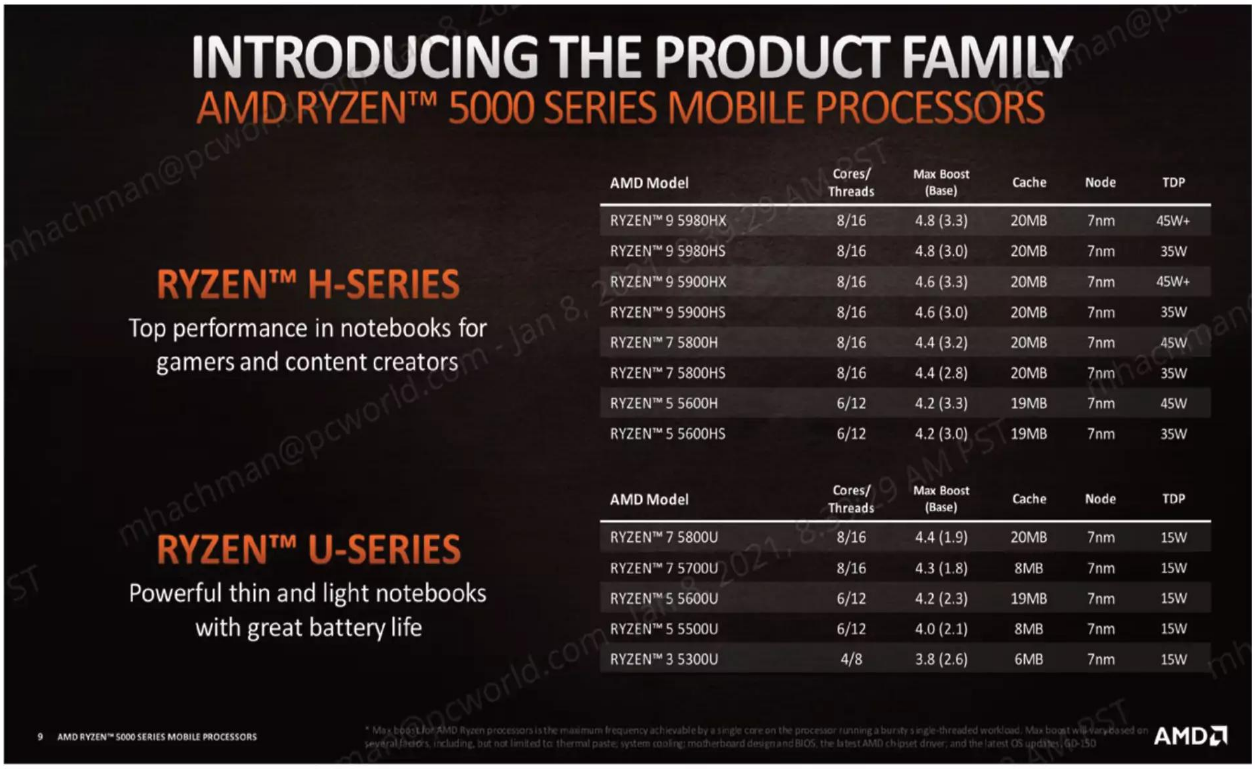
IMAGE: AMD

resolution and Ultra High settings at more than 50fps.

Processors, though, took center stage. AMD launched thirteen new chips in the AMD Ryzen 5000 Mobile series of processors, adding updated 5900HS and 5980HS flagship processors as well as the 5900HX, which AMD brags will be the "world's best processor for gamers." These high-end 7nm processors will top out at 8 cores and 16 threads, with turbo clock speeds maxing out at 4.8 GHz and many of them doubling cache sizes to between 19MB to 20MB for even more overall performance. While most of these new Ryzen processors are designed for 15, 35, and 45 watts, these new HX chips afford laptop makers the option for more than 45-watt designs.

If there's a kicker, well, it's that the rumors were (mostly) true (go.pcworld.com/true): AMD mixed in some processors that use the older Zen 2 architecture inside the Ryzen 5000 series, without specifically distinguishing one from the other. You'll want to pay close attention to which Ryzen laptop you buy beginning in February, when the new Ryzen Mobile 5000 family goes on sale. AMD didn't publish the graphics capabilities of the new chips, either.

"Now, [many] good things have been written about the Ryzen 4000 series—various experts have called them game-changing, or



INTRODUCING THE PRODUCT FAMILY

AMD RYZEN™ 5000 SERIES MOBILE PROCESSORS

RYZEN™ H-SERIES

Top performance in notebooks for gamers and content creators

AMD Model	Cores/ Threads	Max Boost (Base)	Cache	Node	TDP
RYZEN™ 9 5980HX	8/16	4.8 (3.3)	20MB	7nm	45W+
RYZEN™ 9 5980HS	8/16	4.8 (3.0)	20MB	7nm	35W
RYZEN™ 9 5900HX	8/16	4.6 (3.3)	20MB	7nm	45W+
RYZEN™ 9 5900HS	8/16	4.6 (3.0)	20MB	7nm	35W
RYZEN™ 7 5800H	8/16	4.4 (3.2)	20MB	7nm	45W
RYZEN™ 7 5800HS	8/16	4.4 (2.8)	20MB	7nm	35W
RYZEN™ 5 5600H	6/12	4.2 (3.3)	19MB	7nm	45W
RYZEN™ 5 5600HS	6/12	4.2 (3.0)	19MB	7nm	35W

RYZEN™ U-SERIES

Powerful thin and light notebooks with great battery life

AMD Model	Cores/ Threads	Max Boost (Base)	Cache	Node	TDP
RYZEN™ 7 5800U	8/16	4.4 (1.9)	20MB	7nm	15W
RYZEN™ 7 5700U	8/16	4.3 (1.8)	8MB	7nm	15W
RYZEN™ 5 5600U	6/12	4.2 (2.3)	19MB	7nm	15W
RYZEN™ 5 5500U	6/12	4.0 (2.1)	8MB	7nm	15W
RYZEN™ 3 5300U	4/8	3.8 (2.6)	6MB	7nm	15W

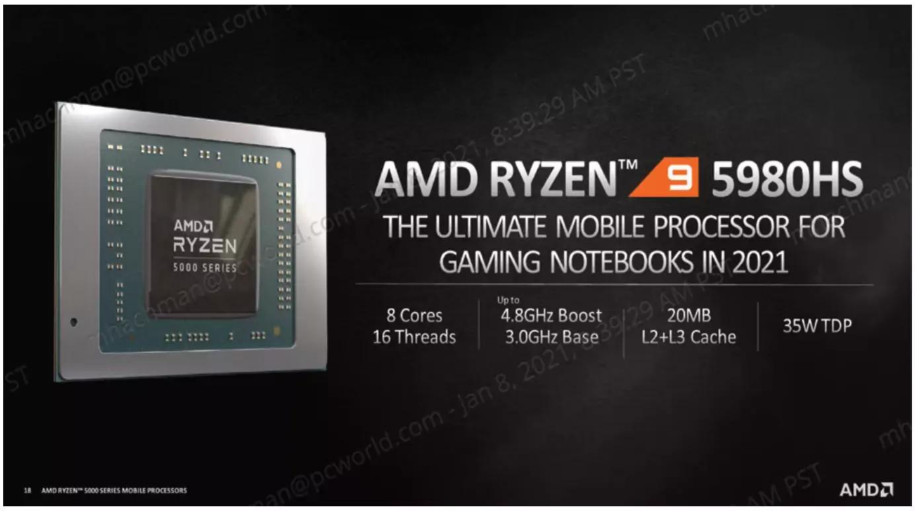
9 AMD RYZEN™ 5000 SERIES MOBILE PROCESSORS

* Max boost for AMD Ryzen processors is the maximum frequency achievable by a single core on the processor running a bursty single-threaded workload. Max boost will vary based on several factors, including, but not limited to: thermal paste; system cooling; motherboard design and BIOS; the latest AMD chipset driver; and the latest OS updates. GD-150

AMD

mhachman@pcworld.com - Jan 8, 2021, 8:39:29 AM PST

AMD's Ryzen Mobile 5000 family. AMD said after publication that the cache size of the Ryzen 5700U should be 12MB, and the Ryzen 5 5500U should have an 11MB cache.


AMD
RYZEN
5000 SERIES

AMD RYZEN™ 9 5980HS

THE ULTIMATE MOBILE PROCESSOR FOR GAMING NOTEBOOKS IN 2021

8 Cores 16 Threads	Up to 4.8GHz Boost 3.0GHz Base	20MB L2+L3 Cache	35W TDP

18 AMD RYZEN™ 5000 SERIES MOBILE PROCESSORS

AMD

rewriting the rules, and we really appreciate that," said Robert Hallock, director of technical marketing for AMD. "But the 5000 series is even better. It's really a remarkable product."

RYZEN 5000 MOBILE: AMD'S ZEN 3 FOR MOBILE

AMD's new processors include five processors within its U-series for thin-and-light notebooks, as well as eight more H-series chips for gaming notebooks. Both AMD and Intel have prioritized gaming at CES, as much to encourage sales of higher-end chips as well as to tap the groundswell of gaming that's grown during the pandemic.

Here are AMD's Ryzen 5000 series mobile processors. All of the new processors are manufactured on AMD's 7nm manufacturing line, and all include simultaneous multithreading, too.

Recall that AMD's Ryzen 4000 Mobile series introduced the Ryzen 4900HS (go.pcworld.com/r4bk), AMD's power processor for slim systems. AMD's Ryzen 5000 Mobile processor lineup is deeper than its predecessor, and the three Ryzen 4000 HS chips have given way to four Ryzen 5000 HS chips, too.

But while AMD claims that the "HS" lineup is then "ultimate in portable gaming performance," there's now something even better: the HX series. Can you actually go better than ultimate?

Apparently you can. The new Ryzen 9 5900HX, and by extension the HX family as a whole, are "the world's best mobile processors for gamers," according to AMD. While an HS-series chip like the Ryzen 9 5980HS is a 35W chip, the 5900HX and 5980HX are rated for 45 watts and above—how high, we're not sure. AMD says HX-series processors are unlocked, too, so enthusiasts can tinker with their clock speeds.

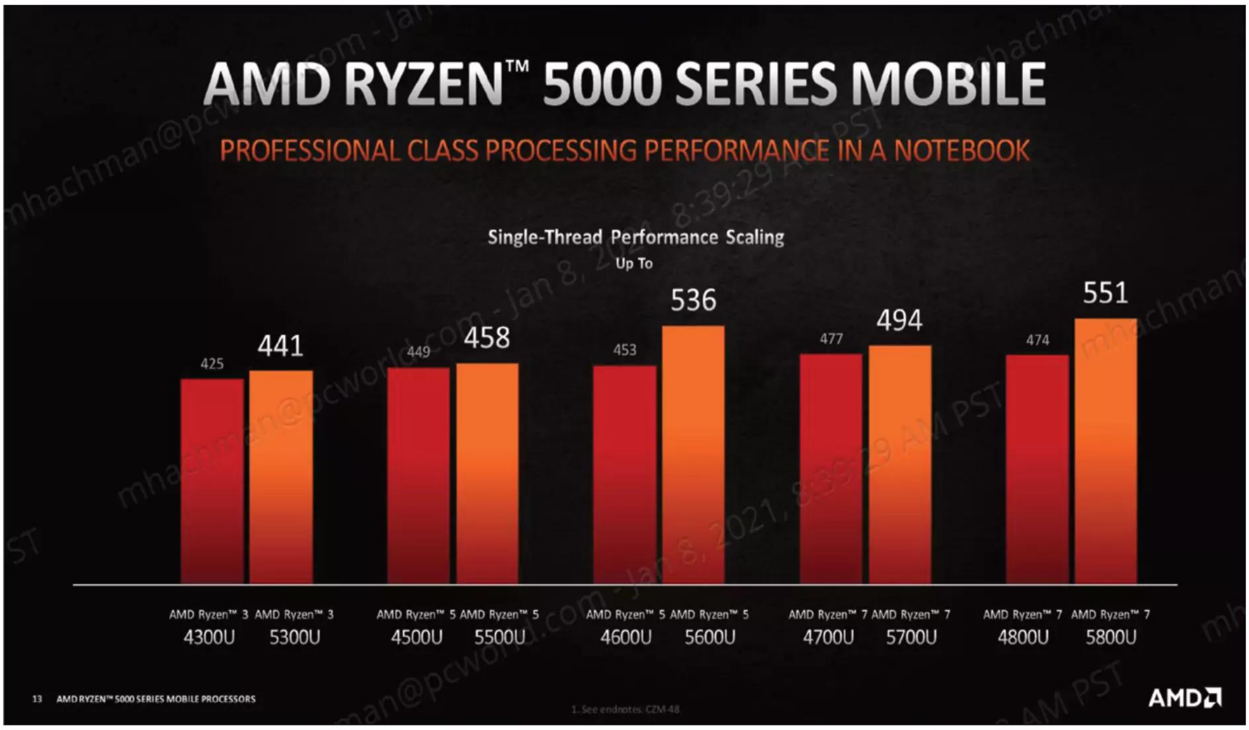
POWER: AS IMPORTANT AS PERFORMANCE, OR MORE SO

It may seem odd to focus on power rather than performance, but the gains AMD has made with its new chip may be more significant than just pushing its clock speeds and cache higher. With the Ryzen 5000 Mobile family, AMD has transitioned what it calls Collaborative Power Performance Control, a technique that migrates CPU clock and power control to the CPU's own firmware, to the mobile space. Originally, the CPPC feature was part of AMD's "Zen 2" desktop chips, offering minor performance improvements for the Ryzen 3000 series (go.pcworld.com/r3rv). But, since frequency affects power consumption, CPPC should have a more significant effect in a Ryzen laptop's power usage.

Consider: Though the comparison is more than a year old, and pitted AMD's older Ryzen 7 3780U versus the Intel Core i7-1065G7, this head-to-head comparison between otherwise identical Microsoft Surface Laptop 3s (go.pcworld.com/sl3s) was especially compelling. Intel's Core topped AMD's Ryzen by roughly 10 percent in performance benchmarks, but absolutely whupped Ryzen by over 40 percent in battery life.

Since then, AMD has recouped those performance deficiencies, and then some. But director of technical marketing Robert Hallock said that CPPC would add two hours to a Ryzen Mobile 5000 notebook's battery life, for a total of 17.5 hours of general usage and 21 hours of video playback. (That's based upon a Ryzen 7 5800U notebook with a 53 watt-hour battery, playing a 1080p video and using the MobileMark 2018 benchmark. The screen brightness was not disclosed.)

"It's easy to add additional performance to an SOC. It's much harder to deliver great battery life alongside that. But that's what we've managed to do with Zen 3, with seven-nanometer, and with the Ryzen 5000 series," Hallock said.



AMD RYZEN™ 5000 SERIES MOBILE

PROFESSIONAL CLASS PROCESSING PERFORMANCE IN A NOTEBOOK

13 AMD RYZEN™ 5000 SERIES MOBILE PROCESSORS

1. See endnotes: CZM-48

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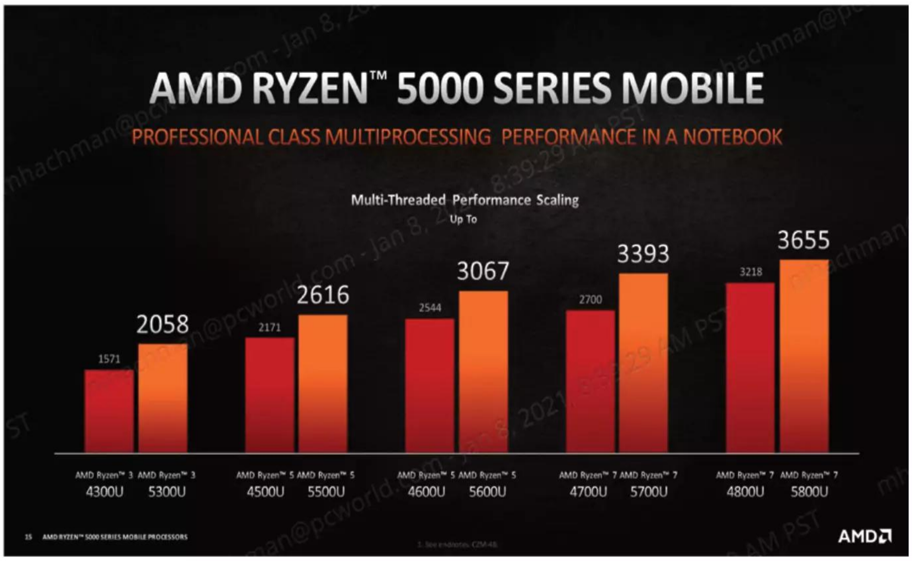


RYZEN 5000 MOBILE: IMPRESSIVE PERFORMANCE

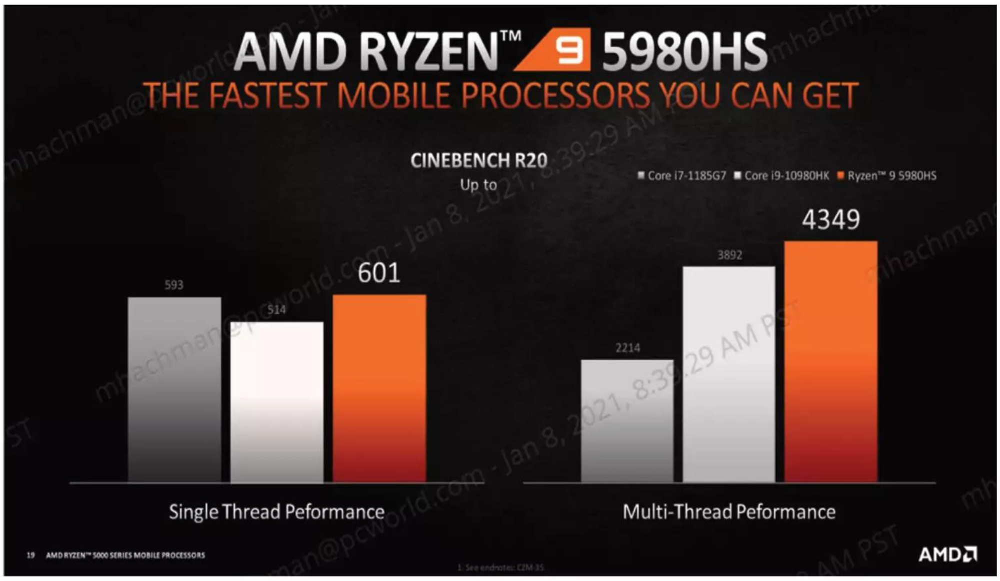
For many, though, performance is king. And AMD certainly made the argument that the Ryzen 5000 Mobile can certainly compete with, if not blow away entirely, the best that Intel has to offer. (You can compare AMD's own results with Intel's own numbers in the mobile 11th-gen "Tiger Lake" presentation Intel released at CES [go.pcworld.com/th35].)

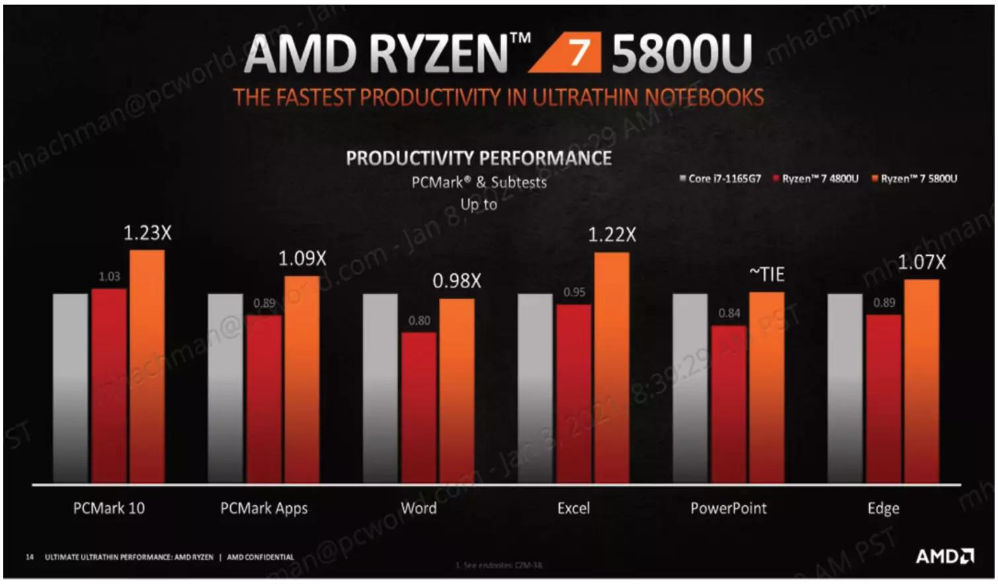
First, gen-over-gen scaling. Pay close attention to the single-threaded scores posted by the Ryzen Mobile 5300U, 5500U, and 5700U scores, as we'll talk about those more in the next section.

AMD also provided multi-threaded scores, too. Here, processors like the 4800U and 5800U contain the same number of cores and threads; the difference is the frequency gap: the Ryzen 7 4800 offers 1.8GHz base clock and 4.2GHz turbo speeds, while the Ryzen 7 5800U provides a 1.9GHz base clock and 4.4GHz turbo speeds.

Kick it up a notch with the Ryzen 9 5980HS and the gains are still impressive.

AMD also touted the ability of the Ryzen 5000 Mobile to compete against its own





AMD RYZEN™ 7 5800U

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Up to

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1. See endnotes: CZM-38

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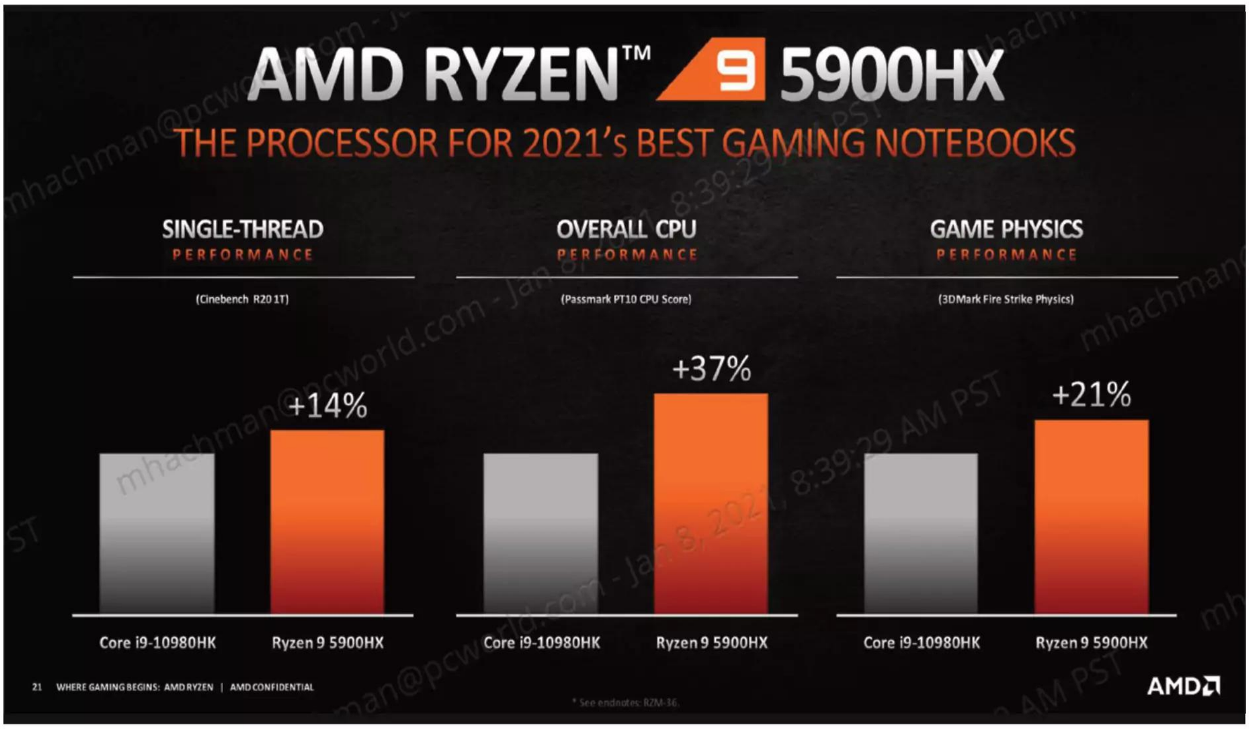
Fire Strike Physics scores are certainly impressive, but AMD didn't actually provide any benchmark scores for games in metrics provided to reporters.

4800U as well as the Core i7-1165G7. Here, the metric is PCMark's productivity apps, though there's sharp gains in Excel and PCMark 10, two of the more intensive apps within the Microsoft office suite.

In gaming, though, AMD had a chance to finish Intel off—and really didn't. The 3DMark

YES, SOME RYZEN 5000 MOBILE PROCESSORS ARE ZEN 2

Early rumors pegged some of the new Ryzen 5000 Mobile processors as using older "Zen 2" cores as opposed to the latest Zen



AMD RYZEN™ 9 5900HX

THE PROCESSOR FOR 2021's BEST GAMING NOTEBOOKS

21 WHERE GAMING BEGINS: AMD RYZEN | AMD CONFIDENTIAL

* See endnotes: RZM-36.

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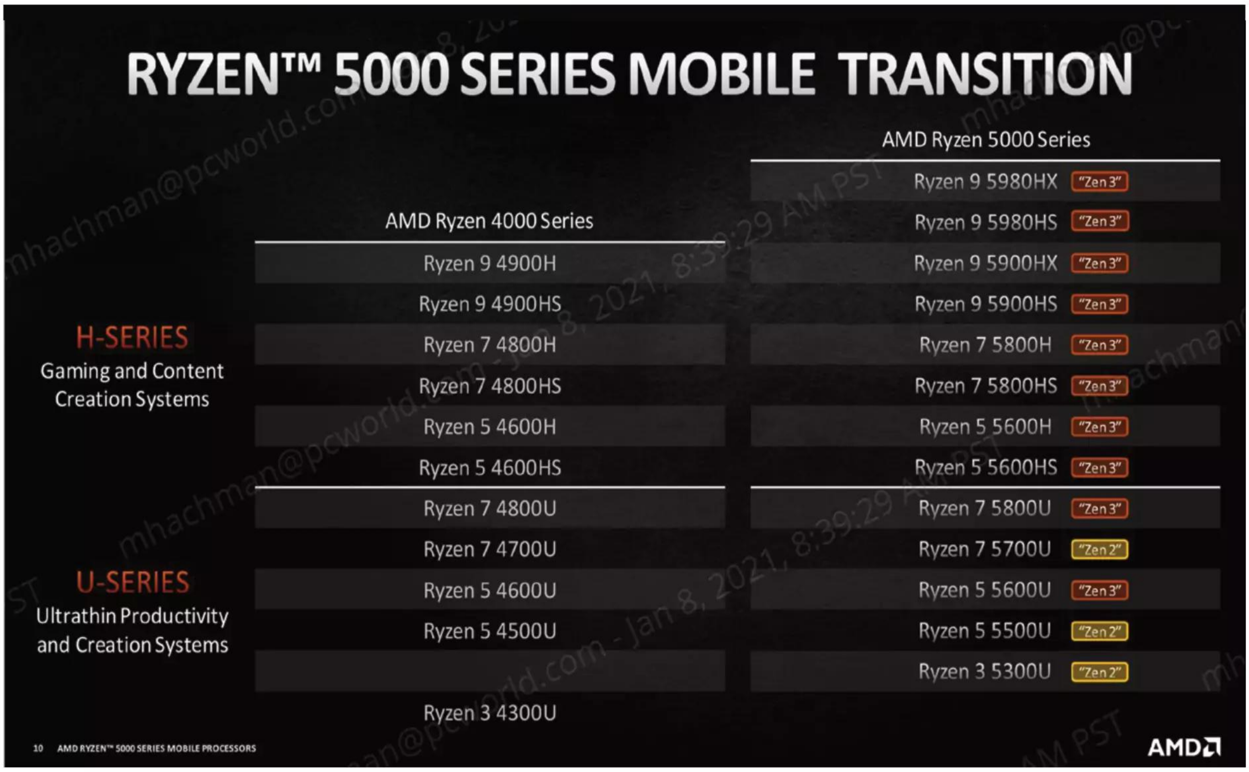
3. AMD's "Lucienne" chips were reportedly designed around AMD's older Zen 2 architecture, and "Cezanne" around the more powerful Zen 3 architecture. AMD's Ryzen 5000 Mobile series included both, those rumors said, without distinguishing one from another (go.pcworld.com/rmz2). Those leaks were, in fact, mostly accurate.

Three of the new Ryzen 5000 mobile processors—the Ryzen 7 5000U, the Ryzen 5 5500U, a nd the Ryzen 3 5300U—use the Zen 2 microarchitecture, according to AMD. Unfortunately, there's no marks or acronyms to distinguish them from the other processors within the family. As the benchmarks showed, however, even the "Zen 2" members of the Ryzen Mobile 5000 series are slightly faster than their Ryzen Mobile 4000 predecessors. If you're interested in avoiding any potential confusion, however, the answer is simple: simply buy one of the new Ryzen 5000 H-series processors.

What's important for AMD is the number of processors it sells. In this, the company may have already notched a success, building upon its design wins in the previous two generations. AMD said that 150 separate mobile PCs will be built upon the Ryzen Mobile 5000 family, versus 100 in the prior generation. In the end, those numbers indicate that AMD has established itself as a leading-edge processor supplier in the eyes of its PC customers.



RYZEN™ 5000 SERIES MOBILE TRANSITION

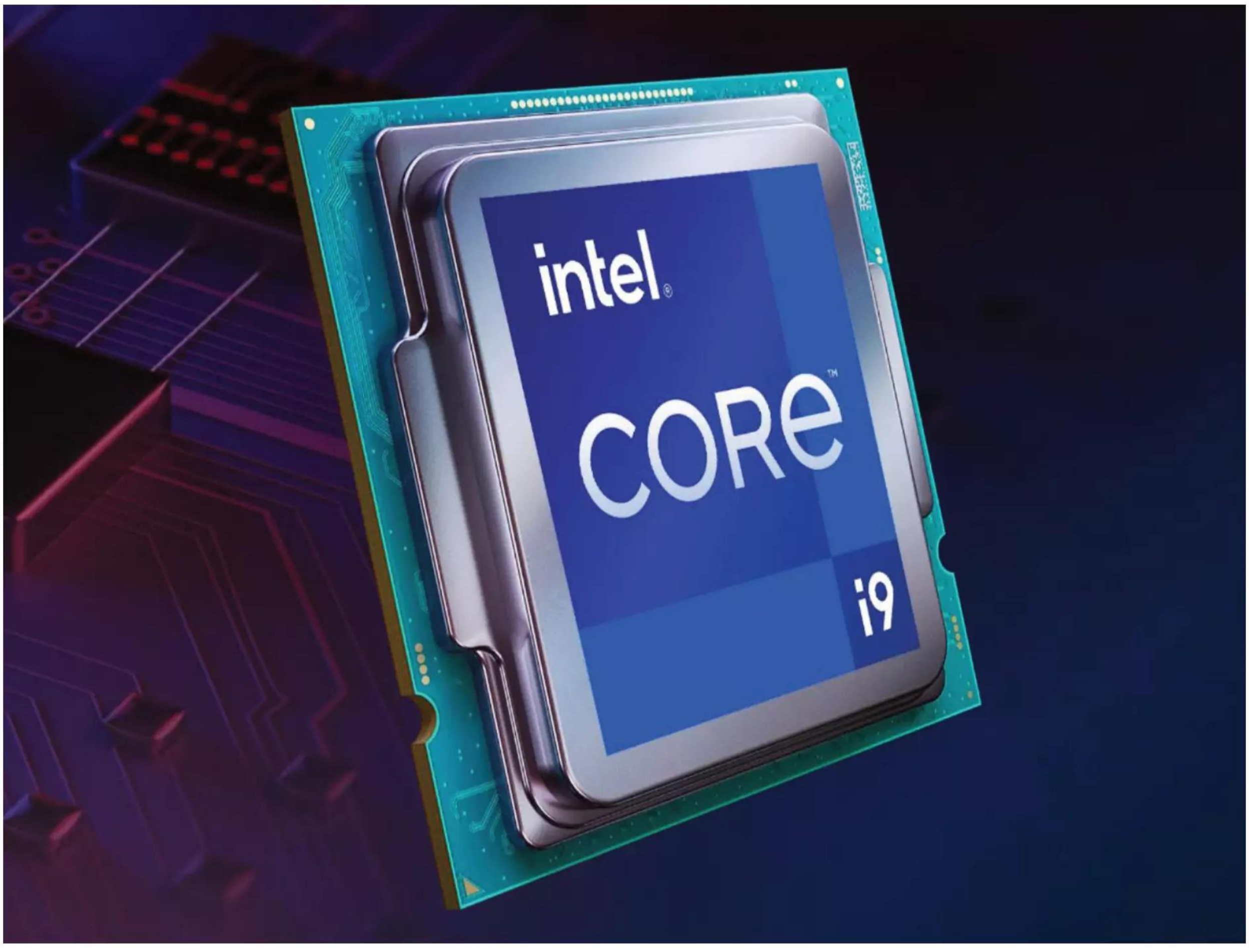
	AMD Ryzen 4000 Series	AMD Ryzen 5000 Series
		Ryzen 9 5980HX "Zen 3"
		Ryzen 9 5980HS "Zen 3"
	Ryzen 9 4900H	Ryzen 9 5900HX "Zen 3"
	Ryzen 9 4900HS	Ryzen 9 5900HS "Zen 3"
H-SERIES Gaming and Content Creation Systems	Ryzen 7 4800H	Ryzen 7 5800H "Zen 3"
	Ryzen 7 4800HS	Ryzen 7 5800HS "Zen 3"
	Ryzen 5 4600H	Ryzen 5 5600H "Zen 3"
	Ryzen 5 4600HS	Ryzen 5 5600HS "Zen 3"
	Ryzen 7 4800U	Ryzen 7 5800U "Zen 3"
	Ryzen 7 4700U	Ryzen 7 5700U "Zen 2"
U-SERIES Ultrathin Productivity and Creation Systems	Ryzen 5 4600U	Ryzen 5 5600U "Zen 3"
	Ryzen 5 4500U	Ryzen 5 5500U "Zen 2"
		Ryzen 3 5300U "Zen 2"
	Ryzen 3 4300U	

10 AMD RYZEN™ 5000 SERIES MOBILE PROCESSORS

AMD

mhachman@pcworld.com - Jan 8, 2021, 8:39:29 AM PST

Yes, some of the Ryzen Mobile 5000 chips use the older Zen 2 architecture. Does that matter?



Intel takes on Ryzen with Rocket Lake S and the Core i9-11900K

Intel's Core i9-11900K is faster than AMD's Ryzen 5900X, Intel says. But Intel still has a lot to talk about with its new Rocket Lake S desktop Core chips. **BY MARK HACHMAN**

Intel debuted its next-generation 11th-gen "Rocket Lake S" desktop Core chips at CES 2021, boasting that its flagship Core i9-11900K processor offers a 19 percent performance improvement over the prior generation, and with gaming performance that rivals AMD's most powerful Ryzen chip.

Intel's Core i9-11900K does take a step back: Intel's 10th-gen Core i9-10900K (go.pcworld.com/i19k) offered 10 cores and 20 threads. The new i9-11900K wields just 8 cores and 16 threads instead, at turbo speeds up to 5.3 GHz (single core) and a slower 4.8GHz (all cores) than the i9-10900K offered. It's also a 14-nanometer chip. But

IMAGE: INTEL

there are subtle, significant improvements, too: a new, wider, 8-lane DMI interface between the processor and chipset, and an increased 20 lanes of PCIe 4.0 off the CPU for GPUs and SSD storage, matching the PCIe 4.0 capabilities that AMD has offered for the last two Ryzen generations. All told, Intel's promising up to a 19 percent IPC (instruction per clock) improvement and a 50 percent boost in integrated graphics performance, thanks to the new, integrated Xe GPU core.

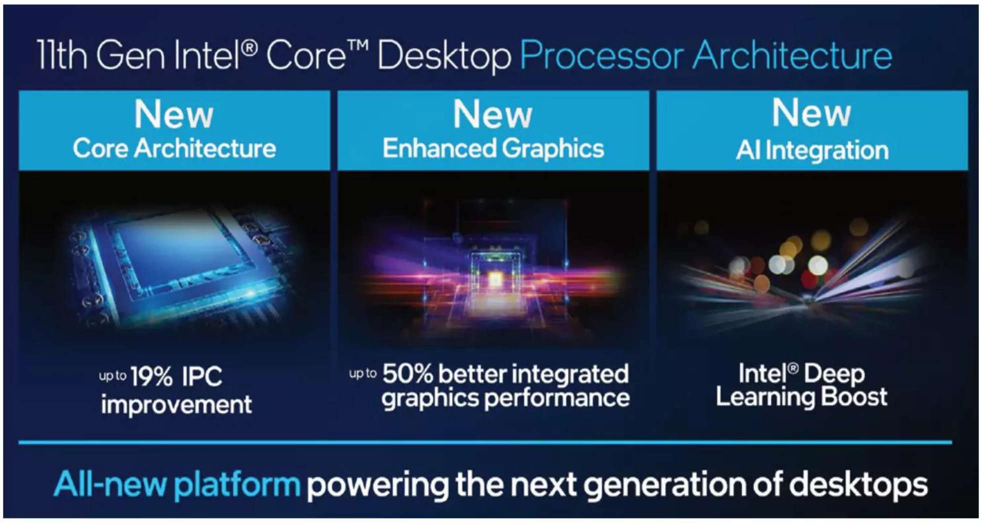
Intel said that the Core i9-11900K will be available later this quarter, at an undisclosed price. Fortunately, though a new 500-series motherboard chipset will be launched alongside it, the i9-11900K will be backwards-compatible with existing 400-series motherboards.

Intel's Gregory Bryant, executive vice president and general manager of Intel's Client Computing Group, also showed off a brief sneak preview of the next-generation Alder Lake hybrid chip (go.pcworld.com/aldr), too. Alder Lake will combine "Golden Cove" Core cores and Gracemont Atom cores in a hybrid design. Bryant also said that it will debut on an "enhanced" 10nm SuperFin process.

ROCKET LAKE...BUT IN 14NM

Many of the features of Rocket Lake-S have been known since last October, when Intel confirmed the existence of Rocket Lake (go.pcworld.com/lkcn) and its new CPU architecture, code-named Cypress Cove. What we *didn't* know was whether the new chip would embrace Intel's latest 10nm process or be manufactured on the relatively ancient 14nm line. Well, now we know: it's a 14nm chip, which also explains the drop in core count, acknowledged Brandt Guttridge, Intel's senior director of the Desktop Products Group. The Cypress Cove CPU core originally designed for 10nm was backported to the 14nm technology, he said.

"I think one of the questions many of you might have right away is, *Why are you going from*

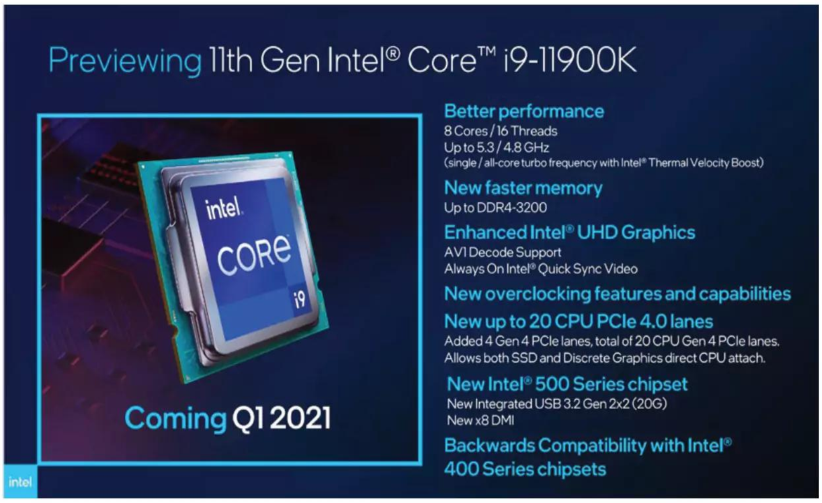


11th Gen Intel® Core™ Desktop Processor Architecture

New Core Architecture	New Enhanced Graphics	New AI Integration
up to 19% IPC improvement	up to 50% better integrated graphics performance	Intel® Deep Learning Boost

All-new platform powering the next generation of desktops

A summary of Intel's new Rocket Lake-S platform.



Previewing 11th Gen Intel® Core™ i9-11900K

Better performance
8 Cores / 16 Threads
Up to 5.3 / 4.8 GHz
(single / all-core turbo frequency with Intel® Thermal Velocity Boost)

New faster memory
Up to DDR4-3200

Enhanced Intel® UHD Graphics
AV1 Decode Support
Always On Intel® Quick Sync Video

New overclocking features and capabilities

New up to 20 CPU PCIe 4.0 lanes
Added 4 Gen 4 PCIe lanes, total of 20 CPU Gen 4 PCIe lanes.
Allows both SSD and Discrete Graphics direct CPU attach.

New Intel® 500 Series chipset
New Integrated USB 3.2 Gen 2x2 (20G)
New x8 DMI

Backwards Compatibility with Intel® 400 Series chipsets

Coming Q1 2021

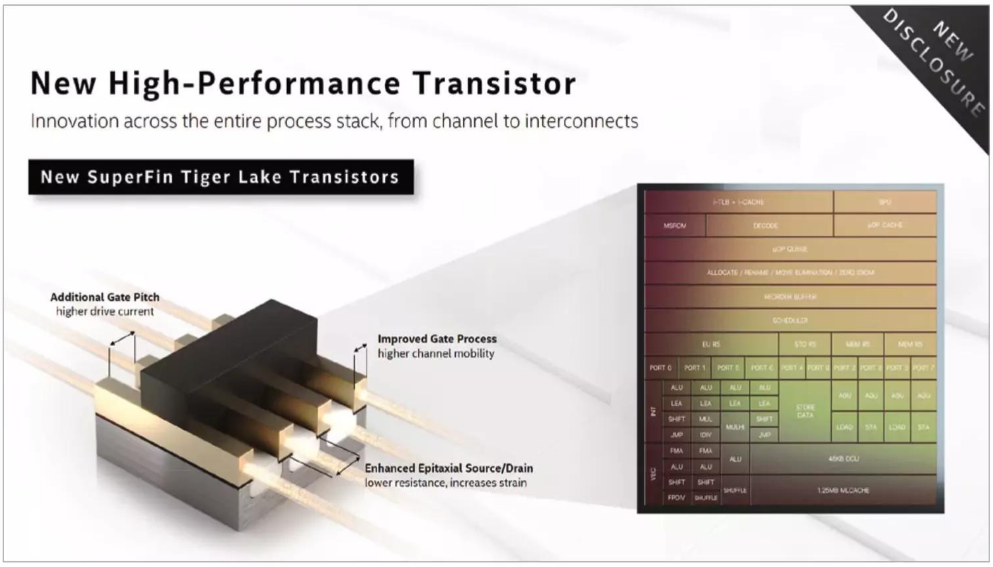
This is as much as we know of the details of the Core i9-11900K.

ten to eight cores?" Guttridge said. "The answer to that question really goes back to… our focus was on maximizing real world performance, which is a combination of frequency and IPC [instructions per clock]. So as we looked at the microarchitecture, we ported the 10nm design for both the CPU and the graphics back to the 14nm manufacturing node. As the 10nm design has smaller transistors and the 14nm is a bit larger set, the maximum core count we could fit on Rocket Lake was eight."

The other factor influencing Intel's choice was that moving to 14nm allowed the company to take advantage of the SuperFIN transistor that Intel added to Tiger Lake (go.pcworld.com/sfin). Last year, Ruth Brain, an Intel fellow specializing in technology development and interconnects, said the sum total of all of the intranode improvements made in the 14nm generations would be equaled by the one intranode performance increase from Ice Lake to Tiger Lake, via SuperFIN.

"That trade off we got was that 19 percent IPC gain…and the 50 percent graphics improvement," Guttridge said. "So again, the focus here was on maximizing performance for the end users in the real world."

Intel didn't specify whether Rocket Lake S formally includes DMI 4.0, though Guttridge



New High-Performance Transistor

Innovation across the entire process stack, from channel to interconnects

New SuperFin Tiger Lake Transistors

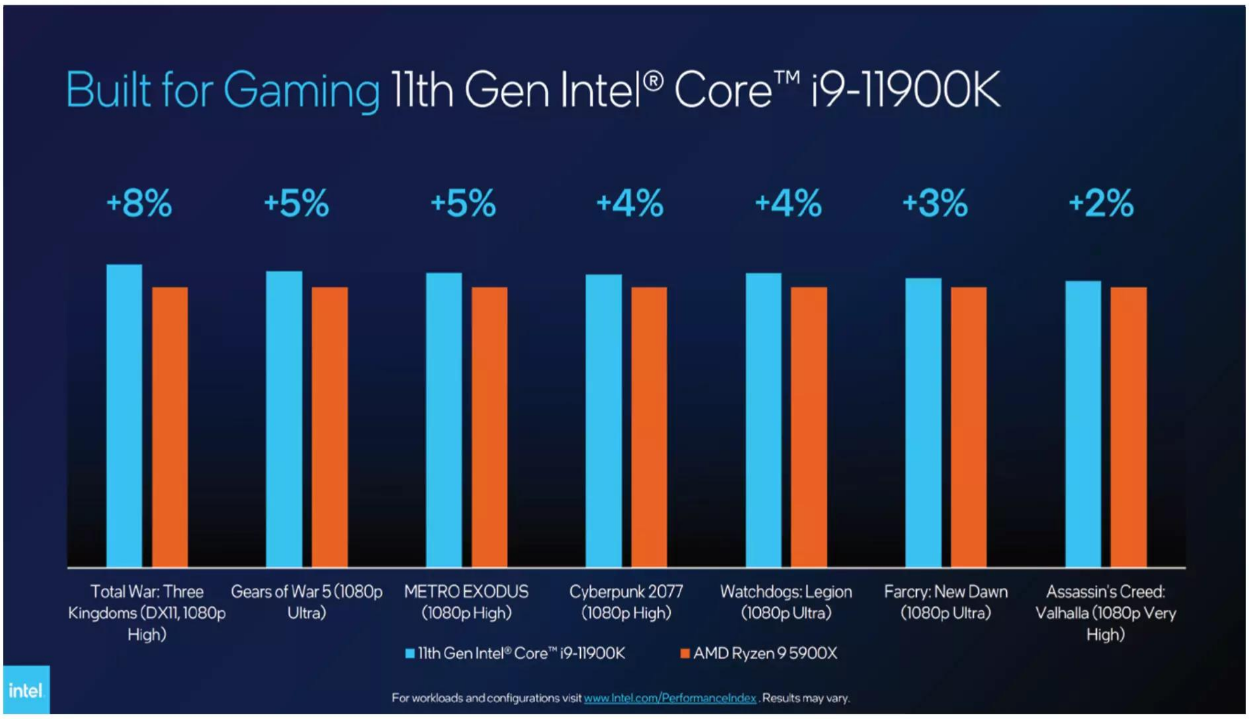
Moving to 14nm allowed Intel to take advantage of Tiger Lake's SuperFIN transistor.

confirmed that the interface now doubles the available lanes from four to eight. The Direct Media Interface connects the CPU and north bridge of the chipset to the PCH or south bridge. Intel's Skylake processor, equipped with DMI 3.0, was the first to include a total of four lanes. Guttridge confirmed that Rocket Lake S provides eight lanes, doubling the bandwidth, which means that Intel has kept the link speed constant.

In terms of gaming performance, Intel claims that Rocket Lake-S should improve performance by about 7 percent on IO Interactive's unreleased *Hitman 3*, running on top of the game's built-in benchmark. Intel also claimed that the Core i9-11900K slightly outperformed the AMD Ryzen 5900X on several top-tier games, from *Total War: Three Kingdoms* to *Cyberpunk 2077* to *Watch Dogs: Legion* to *Assassin's Creed: Valhalla*, all running at 1080p and High settings or above. However, Intel didn't publish the configurations of its gaming tests by press time.

Because the Core i9-11900K is more of an introduction, rather than a launch, we don't have the usual "speeds and feeds" matrix describing the base clock speeds and turbo clock speeds are at various levels, and so on. We also don't know how many EUs are part of the 11900K, either.

Guttridge did explain some more of the decisions Intel made on choosing the Rocket Lake S features that Intel had previously revealed. Customers had asked for faster



Intel believes that the Core i9-11900K will give AMD's Ryzen a run for its money. At press time, the configuration of the system Intel used in preparing this test wasn't available.

memory, prompting Intel to move from DDR4-2933 on "Comet Lake" to the DDR4-3200 memory used by Rocket Lake S. Moving from 16 lanes of PCI Express 3.0 to 20 lanes of PCI Express 4.0 also allowed enough lanes for both a 4-lane PCIe SSD, as well as the 16 lanes used by the latest GPU. Rocket Lake-S also includes hardware decode support for AV1 (and videos stored in the AVIF file format) which compresses data 50 percent more efficiently than the x254 main profile, reducing bandwidth needs for those who use it. USB 3.2 Gen 2x2 increases the available USB bandwidth from 10Gbps to 20Gbps overall.

Rocket Lake-S also includes always-on Intel Quick Sync Video, which Guttridge says now works concurrently with the integrated GPU. Previously, only one desktop GPU (either the integrated GPU or the discrete GPU) could be on at a single time. Now, both can be active, allowing the discrete GPU to be wholly purposed on rendering a game, for example, while the integrated GPU encodes the output for streaming video.

WHAT WE DON'T KNOW: CHIPSET DETAILS, OVERCLOCKING

What we don't know includes what Intel is doing specifically with overclocking in mind. Guttridge promised Intel would have more to share on overclocking capabilities closer to launch, as the company plans to "push the boundaries on delivering customization tunability and optimizations to our end users."

We also don't have official, specific details on the new 500-series motherboard chipsets that will launch with Rocket Lake-S, though the chip will be able to be used with the older 400-series chipsets—at least theoretically. Guttridge recommended that buyers contact motherboard vendors and confirm that "PCI Express 4.0-ready" motherboards will have the capability turned on and the proper BIOS installed. Guttridge said that the change in the DMI interface won't affect the backwards compatibility of the Rocket Lake-S chip. Board makers, however, have begun spilling the beans. We know that there will be at least three chipsets: the Z590, H570, B560 and H510. Asus said that the ROG Maximus XIII Z590 board will include a pair of Thunderbolt 4 ports, one of the few specs we know at the moment.

One processor that Intel *didn't* compare itself to was Apple's M1, the ARM chip that will replace the Core i7 and Core i9 inside the MacBook and other devices. Ryan Shrout of Intel's competitive performance team summed up Intel's stance: "I'd say, you know, Apple did an excellent job on their processor."

Still, Shrout added, there's room for Intel to compete. "The truth is that our testing shows there are many areas of leadership for our 11th-gen Tiger Lake products across productivity, content creation, and especially gaming," he said. ⏻

Nvidia woos mainstream gamers with the $329 GeForce RTX 3060 and RTX 30-series laptops

Game On, indeed. **BY BRAD CHACOS**

GEFORCE RTX

Nvidia held its big "GeForce RTX: Game On" event as part of CES 2021, and as expected (go.pcworld.com/21pr), the company revealed a flood of fresh features and hardware for gamers. Not only did Nvidia unveil mobile GeForce RTX 30-series GPUs for laptops, but it also announced a new GeForce RTX 3060 graphics card for the desktop, an expansion of its Reflex Latency Analyzer displays, and plans to support the performance-boosting PCIe Resizable BAR feature that AMD introduced with the Radeon RX 6000-series as AMD Smart Access Memory.

Oh, and *Call of Duty: Warzone* and the next *Five Nights at Freddy's* game are getting Nvidia's spectacular DLSS 2.0 technology

IMAGE: NVIDIA

(go.pcworld.com/2dls), with Freddy's wrapping in real-time ray tracing as well.

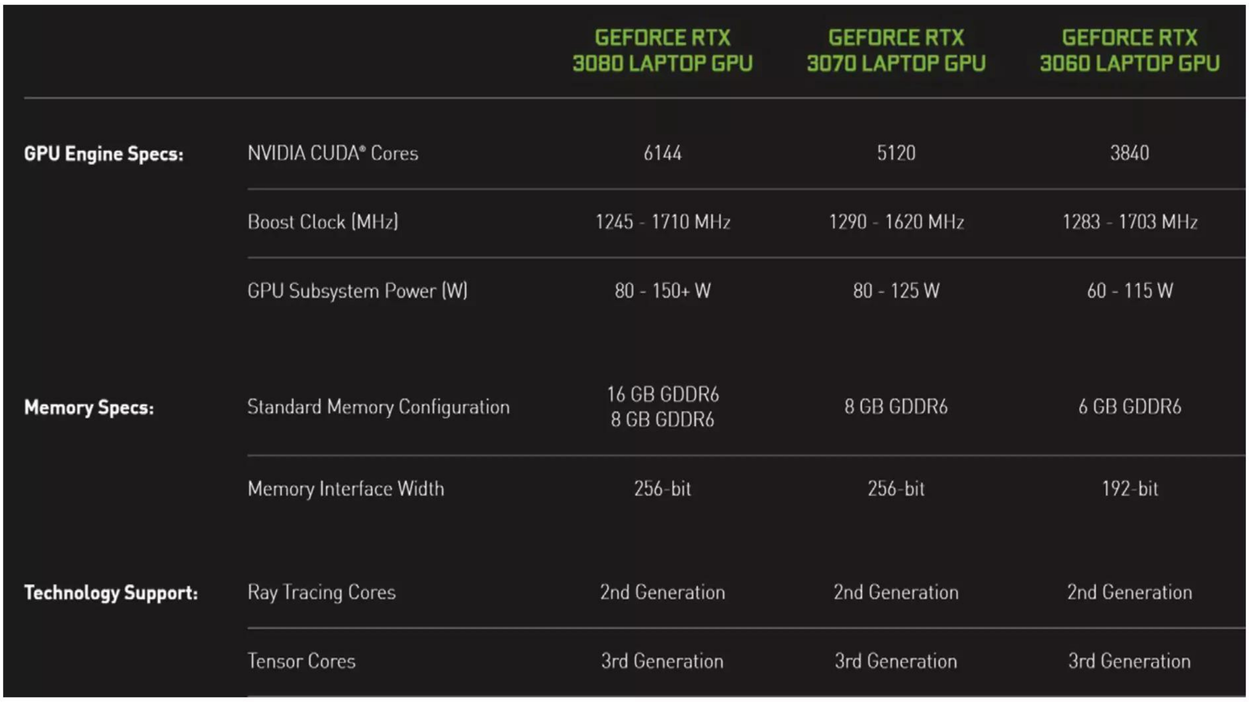
Phew.

GEFORCE RTX 30-SERIES FOR LAPTOPS

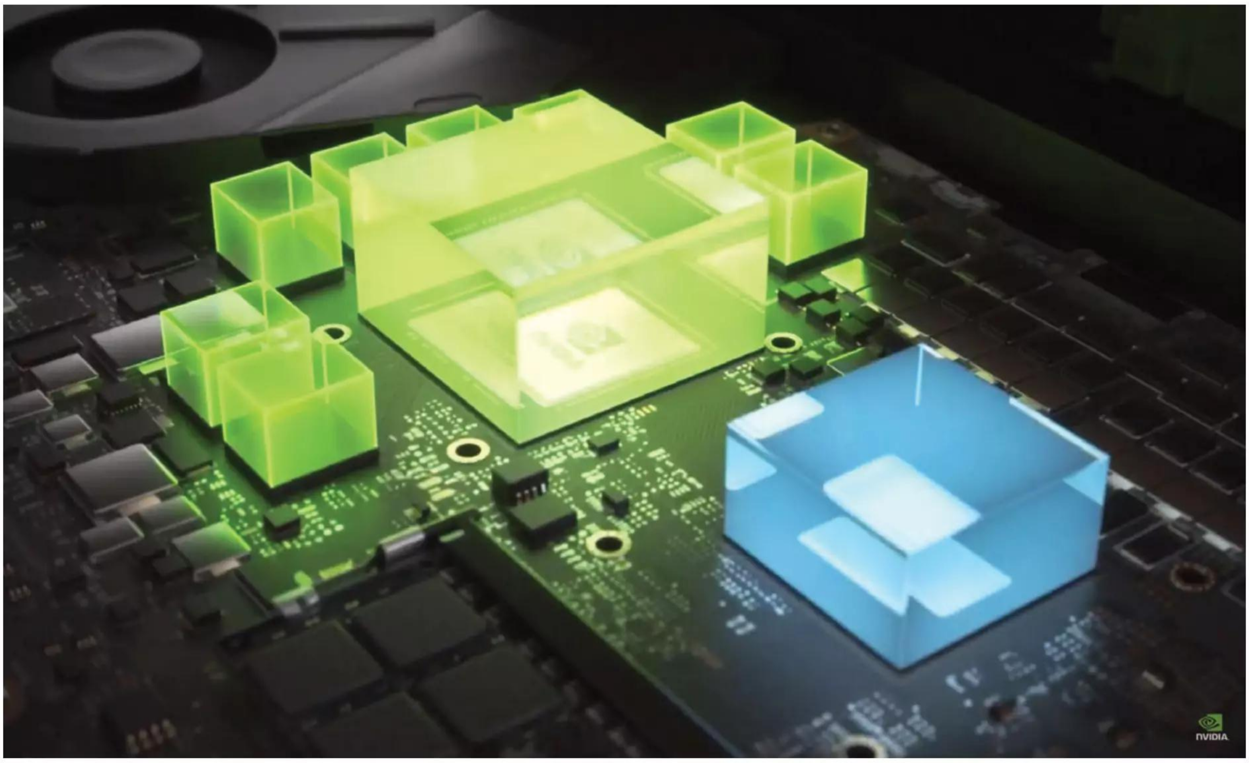
Let's start with the mobile GeForce RTX 30-series GPUs, which will likely be found inside many of the gaming laptops announced at CES alongside AMD and Intel's (go.pcworld.com/hl35) newly unveiled notebook processors. Nvidia revealed three mobile chips based on the company's next-gen Ampere GPU architecture: The GeForce RTX 3080, 3070, and 3060, mirroring what's available in desktops.

The 6GB GeForce RTX 3060 may be the most modest offering, but Nvidia's Jeff Fisher says it's still faster than any gaming laptop currently available, besting the previous RTX 2080 Super flagship. Nvidia says the mobile chip is 30 percent faster than Sony's new PlayStation 5 console, capable of hitting 90 frames per second during 1080p gaming.

Modern graphics cards are outpacing 1080p resolution, however. Nvidia says it's been working closely with panel and laptop makers to make 1440p screens more readily available (go.pcworld.com/bl4k). The two graphics cards already announced in late 2020 were designed to scratch that itch. The 8GB GeForce RTX 3070 is to up 50 percent faster than the RTX 2070 mobile chip it replaces, achieving 90 fps at 1440p. The flagship RTX 3080 hits a claimed 100 fps at 1440p,



		GEFORCE RTX 3080 LAPTOP GPU	GEFORCE RTX 3070 LAPTOP GPU	GEFORCE RTX 3060 LAPTOP GPU
GPU Engine Specs:	NVIDIA CUDA® Cores	6144	5120	3840
	Boost Clock (MHz)	1245 - 1710 MHz	1290 - 1620 MHz	1283 - 1703 MHz
	GPU Subsystem Power (W)	80 - 150+ W	80 - 125 W	60 - 115 W
Memory Specs:	Standard Memory Configuration	16 GB GDDR6 8 GB GDDR6	8 GB GDDR6	6 GB GDDR6
	Memory Interface Width	256-bit	256-bit	192-bit
Technology Support:	Ray Tracing Cores	2nd Generation	2nd Generation	2nd Generation
	Tensor Cores	3rd Generation	3rd Generation	3rd Generation



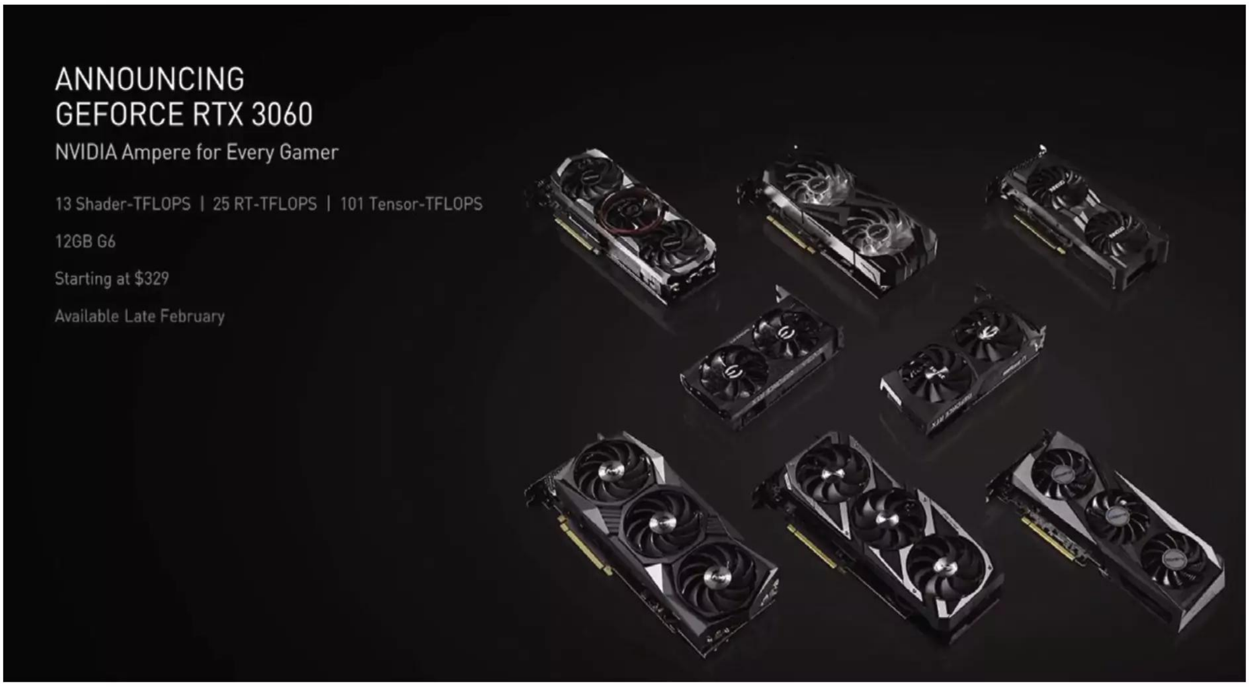
Dynamic Boost 2.0 now manages the GPU VRAM power levels as well.

bolstered by a beefy 16GB of onboard memory.

Interestingly, the CUDA cores counts for these mobile models don't mirror the desktop versions, breaking the standard that's been set over the previous few generations. The laptop RTX 3080 wields 6,144 CUDA cores versus nearly 9,000 in the desktop model; the RTX 3070 mobile chip packs 768 fewer cores than its desktop cousin; and believe it or not, the mobile RTX 3060 actually has more CUDA cores than the just-announced laptop version, with 3,840 versus 3,584.

That means the notebook version of the RTX 3080 only offers a few hundred more cores than the desktop 3070, which provides insight into the type of performance levels to expect. Ampere uses big dies cranked to the max on the desktop, but that full-fledged performance seemingly can't translate wholly over to the world of notebooks, where energy efficiency is paramount.

Nvidia says the third-gen implementation of its Max-Q technology in these new GPUs offer twice the efficiency of past iterations. Note that some of those claims are tied into the DLSS feature that's available only in select games, making the comparison not as straightforward as it seems. The other Max-Q improvements look very compelling, however, with a second-gen Dynamic Boost that



ANNOUNCING
GEFORCE RTX 3060
NVIDIA Ampere for Every Gamer

13 Shader-TFLOPS | 25 RT-TFLOPS | 101 Tensor-TFLOPS
12GB G6
Starting at $329
Available Late February

intelligently shifts power between the GPU memory as well as the core CPU and GPU, and an upgraded version of Whisper Mode that uses AI algorithms to tune your components to hit an acoustic level determined by the user. The third-gen Max-Q offering also enables Resizable BAR support, which we'll detail more later.

Look for laptops built using Nvidia's new generation of GeForce mobile GPUs to launch on January 26, with every major OEM chipping into the more than 70 total models coming. Nvidia says GeForce RTX 3060 laptops will start at $999, RTX 3070 laptops will start at $1,299, and RTX 3080 laptops will kick off at $1,999.

GEFORCE RTX 3060

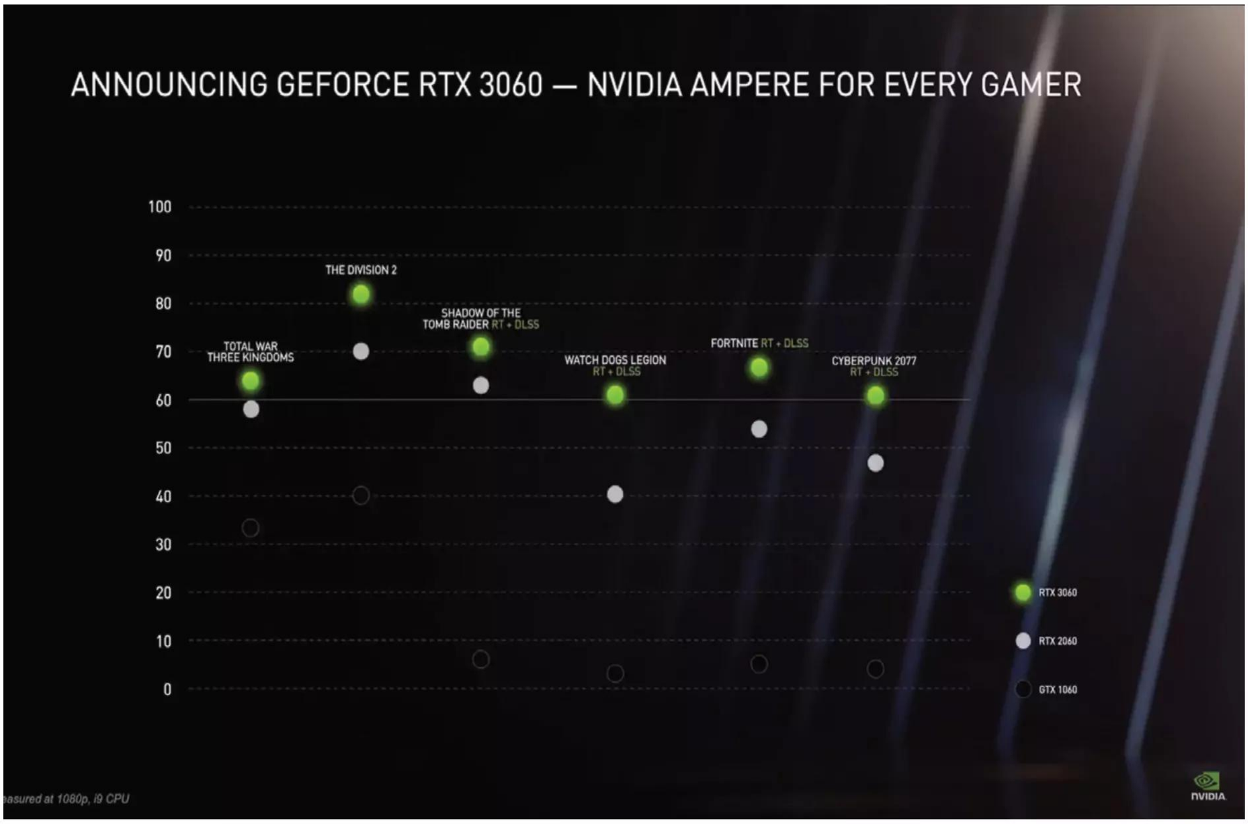
Nvidia also teased a new toy for diehard desktop gamers. After flooding the high end with the GeForce RTX 3090 (go.pcworld.com/90fe), 3080 (go.pcworld.com/fe80), 3070 (go.pcworld.com/fed7), and 3060 Ti (go.pcworld.com/6fed), the GeForce RTX 3060 finally brings Ampere down to a more affordable price point with a $329 MSRP when it launches in late February—at least theoretically.

In reality, we expect the RTX 3060 to sell out immediately and likely be priced much higher on the street, like we've seen with every other next-gen graphics card released so far. Rival AMD declined to reveal more mainstream-priced Radeon offerings during its CES keynote, saying only that mainstream Radeon GPUs will launch in the first half. Meanwhile, Nvidia is set up to sell as many RTX 3060s as it can pump out in the near future. Fingers crossed there will be abundant supply.

Nvidia revealed scant technical details about the GeForce RTX 3060, but the company claims the card offers twice as much traditional rasterization performance as the beloved GeForce GTX 1060, and 10X the ray tracing performance. (The GTX 1060 doesn't include dedicated real-time ray tracing cores like RTX-class GeForce cards do). Interestingly, the GeForce RTX 3060 includes an ample 12GB of GDDR6 memory, more than the limited 8GB available in the more powerful RTX 3060 Ti and 3070. It uses a smaller 192-bit bus however. Looks like AMD's offer of vastly more VRAM in the Radeon RX 6000-series had an effect on Team Green.

The GeForce RTX 3060 product page (go.pcworld.com/pdpg) offers more details, however, comparing the card against the $400 RTX 3060 Ti. It will include 3,584 CUDA cores clocked at a 1.78GHz boost speed. The spec sheet doesn't detail physical information like size or the connector loadout, but this will be a 170-watt card that should be paired with a 550W power supply. By contrast, the RTX 3060 Ti is a 200W card that needs a 600W PSU.

Of course, as an RTX 30-series card, the GeForce RTX 3060 supports all of Nvidia's most advanced features, like real-time ray tracing, DLSS, Nvidia Reflex, NVENC encoding, Shadowplay, Nvidia Broadcast, and more.



ANNOUNCING GEFORCE RTX 3060 — NVIDIA AMPERE FOR EVERY GAMER

asured at 1080p, i9 CPU

NVIDIA REFLEX LATENCY ANALYZER

Nvidia's recently introduced Reflex Latency Analyzer G-Sync displays (see page 75) debuted in blazing-fast 360Hz 1080p panels alone, with an eye on esports pros. Nvidia announced five new models at CES, and they include new 1440p and ultrawide offerings. It's a really cool premium feature, and I'm glad to see it spreading its wings.

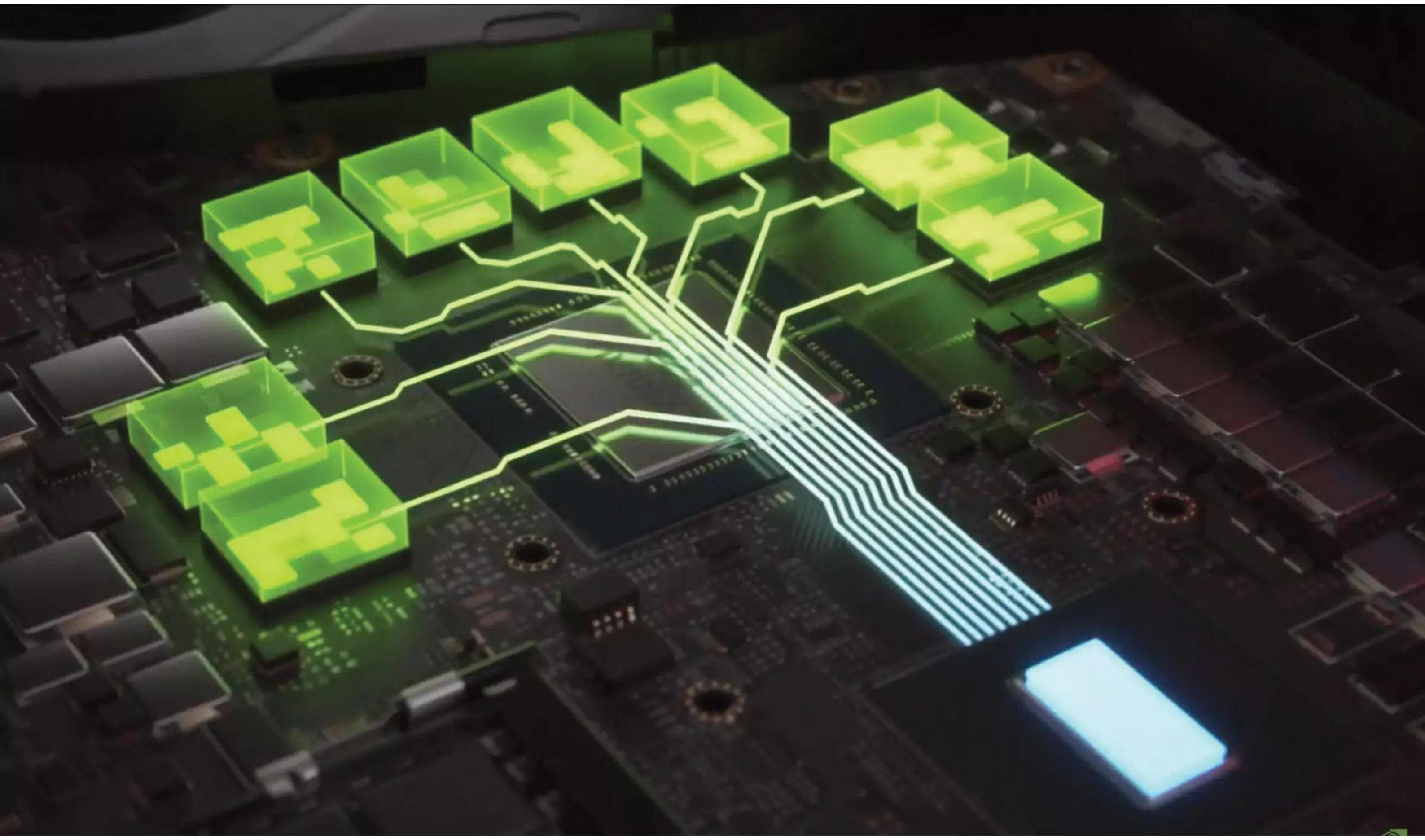
RESIZEABLE BAR

Nvidia's last announcement offers a performance upgrade for all PC gamers on modern hardware. Nvidia said its new GeForce RTX 30-series laptop GPUs will support the PCIe Resizable BAR feature (go.pcworld.com/barf) that AMD introduced first as Smart Access Memory. The desktop GeForce RTX 3060 and all future products will support it out of the gate as well, while existing RTX 30-series GPUs can grab it via an incoming VBIOS update.

Resizable BAR lets your computer's processor access the full memory capacity of your graphics cards, rather than limiting it to the usual 256MB chunks. As we saw when we tested Smart Access Memory with AMD's Radeon RX 6900 XT (go.pcworld.com/smac), the performance gains from Resizable BAR vary greatly from game to game, from GPU to GPU, and even depending on the resolution you're playing at. Sometimes there's no uplift: In many scenarios, you may get roughly four or five percent more frames. In certain edge cases (like Assassin's Creed Valhalla) you may see a double-digit performance improvement.

You need a compatible CPU to activate Resizable BAR. Intel said its new Tiger Lake H35 processors (go.pcworld.com/tlh3) will support

ANNOUNCING
NEW NVIDIA G-SYNC DISPLAYS
Featuring Reflex Latency Analyzer
PREDATOR
Acer Predator XB273U NX
27" 1440p 240Hz IPS

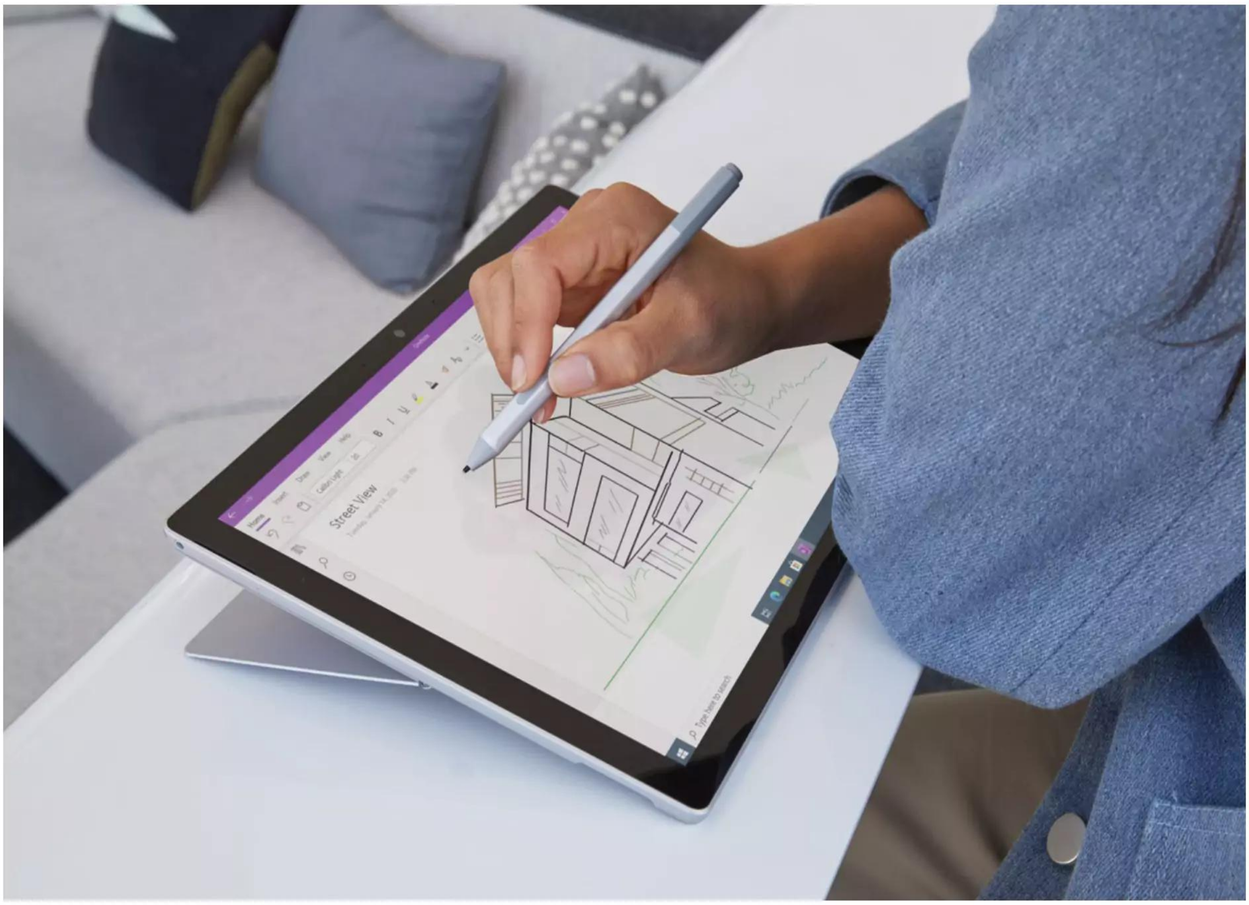


Resizable BAR lets the CPU tap fully into the GPU's memory, offering performance gains in some scenarios.

the feature, and presumably AMD's new Ryzen 5000 Mobile chips (see page 15) will as well, since the company's desktop Ryzen 5000 series (go.pcworld.com/dr50) introduced the technology. AMD hasn't confirmed that, but Nvidia says (go.pcworld.com/nv30) the laptop GPUs work with AMD laptops as well as Intel's.

On the desktop, you'll need a relatively new processor and motherboard to activate Resizable BAR even if your graphics card supports it. AMD rolled out Smart Access Memory with its new Ryzen 5000 desktop processors (go.pcworld.com/dr50) and X570 motherboards. Hopefully the technology will make its way to Intel's new 11th-gen Core "Rocket Lake" CPUs (see page 22) launching later this quarter, especially considering it's included in Tiger Lake. We've already seen some motherboard makers enable the feature on select Z490 boards, so hopefully it will come unlocked on Rocket Lake's Z590 offerings.

Resizable BAR doesn't offer a substantial performance boost in most cases, but it's fantastic to see it rapidly becoming a universal feature. Every frame counts.



Microsoft launches Surface Pro 7+ tablet with Tiger Lake and LTE

Microsoft began taking orders for the Surface Pro 7+ January 11 via its business partners, with shipments beginning the same week. **BY MARK HACHMAN**

Microsoft unexpectedly launched the Surface Pro 7+, a refreshed Surface Pro tablet with Intel's 11th-gen "Tiger Lake" processors inside, LTE options, and the removable SSD that Microsoft first introduced with the Surface Pro X.

Microsoft began taking orders for the Surface Pro 7+, part of the Surface Pro for Business line, on January 11 via its business partners. Prices start at $900. Adding the LTE Advanced option essentially tacks on a substantial premium, with the option only available on more powerful configurations whose price begins at $1,150. Neither price factors in a Signature Type Keyboard and Surface Pen, which cost about $160 and $100, respectively. Matte black and platinum

IMAGE: MICROSOFT

color options are available.

The Surface Pro 7+ name is appropriate, as the Surface Pro 7 (go.pcworld.com/sfp7) included Intel's 10th-gen Ice Lake processors but was otherwise just a spec bump from its predecessor. With the Surface Pro 7+, Microsoft is not only upgrading the internal components, but adding the LTE option off the bat, something that it hasn't always done. (Unfortunately, 5G isn't yet included.) The only apparent physical change is the SSD drawer.

Microsoft's Surface Pro 7+ is almost physically indistinguishable from its predecessor, the Surface Pro 7.

Microsoft positioned the design of the Surface Pro 7+ as at least a partial response to the pandemic, which has forced many of its customers to work from home and adapt to what you might call extraordinary working conditions. For one, Microsoft said that customers have been forced to move around their homes unexpectedly, and work from odd setups; the unexpected demands of Zoom/Teams calls, downloads, and other loads on a home wireless network has made offloading the wireless data burden to a cellular network a convenience, if not a priority.

Internally, users will have a choice of buying versions of the Surface Pro 7+ with either a dual-core Core i3-1115G4 processor, or two quad-core options: the Core i5-1135G7 and the Core i7-1165G7. A change no one will mind: Microsoft has retired the 4GB RAM option, offering 8GB, 16GB, and a new 32GB LPDDR4x memory option.

Users are now accustomed to "camera to camera is the new face to face," added Robin Seller, the corporate vice president of Microsoft Devices, in a blog post (go.pcworld.com/msdv). The new emphasis on videoconferencing has turned the high-resolution cameras built into the Surface Pro 7 (go.pcworld.com/msca) and the new 7+ from luxuries to essentials. The 5MP user-facing camera and an 8MP rear camera both capture 1080p video, and a pair of far-field mics to pick up your voice. It appears that the Surface Pro 7+ speakers have been upgraded to use Dolby Atmos audio technology, which has also been used on the Apple iPad Pro and Amazon Fire HD 10.

Somewhat ironically, the new Tiger Lake processors theoretically offer the new Thunderbolt 4 port option. But Microsoft, which pioneered the high-speed I/O dock with the Surface Dock and its successor, the Surface Dock 2, still chooses to use its own Surface Connector.

Microsoft still apparently hasn't changed its stance toward the removable SSD that the company built into the Surface Pro X and the Surface Laptop 3. Then, Microsoft Store representatives—when Microsoft still operated Microsoft Stores—told us that the removable SSD was being used as a means to migrate data from one Surface Laptop 3/ Surface Pro X to another (go.pcworld.com/mgdt), rather than as a way to allow end users to upgrade their storage options. Microsoft says the Surface Pro 7+ introduces a "removable SSD for data retention."

MICROSOFT SURFACE PRO 7+ BASIC SPECS

Because the Surface Pro 7+ is a Microsoft Surface for Business device, it ships only with Windows 10 Pro. Microsoft 365 apps come standard, with a 30-day trial period before requiring a license.

Display: 12.3-inch PixelSense display (2736x1824)

Processor: Core i3-1115G4 (Wi-Fi), Core i5-1135G7 (Wi-Fi/LTE) Core i7-1165G7 (Wi-Fi)

Graphics: UHS (Core i3), Iris Xe (Core i5, i7)

Memory: 8GB, 16GB LPDDR4x (Wi-Fi, LTE); 32GB LPDDR4x (Wi-Fi)

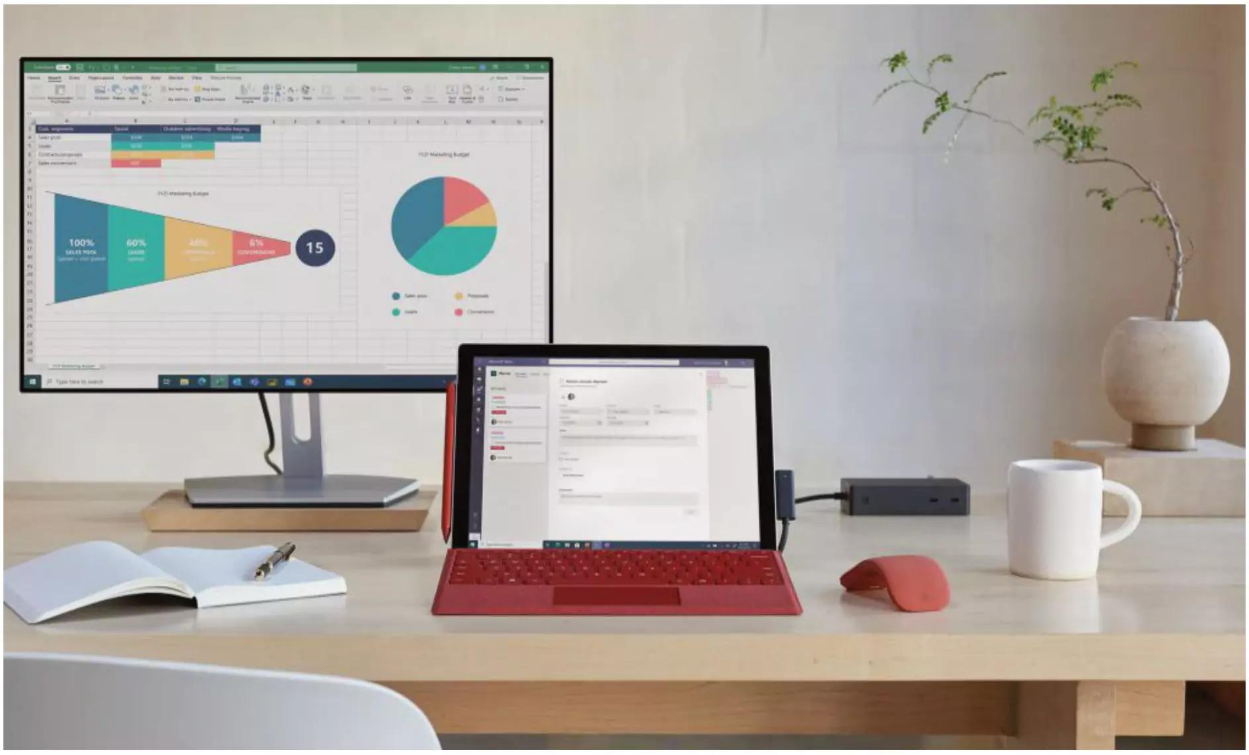
Storage: 128GB or 256GB (Wi-Fi or LTE); 512GB or 1TB (Wi-Fi)

Ports: 1 USB Type C, 1 USB Type A, MicroSDXC reader, Surface Connect, 3.5mm audio jack, nanoSIM

Camera: 5MP front-facing, 8MP rear-facing, w/1080p video

Battery: 15

The Surface Pro 7 adds an SSD drawer, and the ability to swap out the SSD inside.



hours/13.5 hours with LTE Advanced

Wireless: WiFi 6 (802.11ax), Bluetooth 5, Qualcomm X20 modem

Operating system: Windows 10 Pro

Dimensions (inches): 11.5 x 7.5 x 0.33 inches (8.5mm)

Weight: 1.7 pounds

Colors: Platinum, Matte Black

Price: $899 to $2,799

Optional accessories: Surface Pro Signature Type Cover ($160 on Amazon; go.pcworld.com/amcv), Surface Pen ($100 on microsoft.com; go.pcworld.com/mscv).

SURFACE PRO 7+ AVAILABLE CONFIGURATIONS

$900: Core i3/8GB RAM/128GB SSD

$1,000: Core i5/8GB RAM/128GB SSD: $1,000

$1,150: Core i5/8GB RAM/128GB SSD (LTE): $1,150

$1,300: Core i5/8GB RAM/256GB SSD: $1,300

$1,450: Core i5/8GB RAM/256GB SSD (LTE): $1,450

$1,500: Core i5/16GB RAM/256GB SSD

$1,650: Core i5/16GB RAM/256GB SSD (LTE)

$1,600: Core i7/16GB RAM/256GB SSD

$2,000: Core i7/16GB RAM/256GB SSD: $2,000

$2,400: Core i7/16GB RAM/512GB SSD

$2,800: Core i7/32GB RAM/1TB SSD

Acer's swanky new gaming monitors marry high resolutions with ultra-fast speeds

Fast refresh rates? Tons of pixels? Buttery-smooth adaptive sync capabilities? Acer's trio of new gaming monitors offer it all. **BY BRAD CHACOS**

PREDATOR™
PREDATOR

If you've felt the need for gaming speed, Acer's trio of ultra-fast high-resolution monitors might just catch your eye. Announced ahead of CES 2021, all three also offer adaptive sync technology for buttery-smooth, tear-free gaming experiences, as well as TÜV Rheinland Eyesafe (go.pcworld.com/1sfe)-certified screens designed to emit less blue light than standard LCDs. Maybe that'll help you get to sleep

IMAGE: ACER

more quickly after a long, late-night gaming session.

The most interesting display actually rocks the *lowest* resolution. The 27-inch Predator XB273U NX features a 2560x1440-resolution IPS display—PC gaming's sweet spot—but pushed to insane speeds. It hums along at a blistering 265Hz when overclocked, with a 0.5-millisecond grey-to-grey response time. Acer said the monitor is "HDR capable" without offering more detailed specifics (don't expect true 1000-nit HDR visuals) and says the screen covers 95 percent of the DCI-P3 spectrum.

This sort of monitor is built for no-compromises twitch gaming, and as such, Acer baked in Nvidia's new Reflex Latency Analyzer technology. Reflex Latency Analyzer measures how much latency is being added from the various parts of your system—from mouse click to the final frame being drawn—to help you identify hardware that could be holding you back, or just help you evaluate how responsive your games become when tinkering with various graphics settings.

We covered the Latency Analyzer technology in-depth in our look at the Nvidia Reflex suite (see page 75). Previously, you could only find the Reflex Latency Analyzer in 360Hz, 1080p monitors, and it's great to see the technology spreading to other types of panels. As an RLA display, Acer's monitor also includes Nvidia's G-Sync adaptive sync feature.

The Acer Predator XB273U NX will be available in May for prices starting at $1,100. This sort of cutting-edge display tech doesn't come cheap.

If you've moved beyond 1440p, Acer also unveiled a pair of 4K displays with speedy 144Hz refresh rates. Both include AMD's FreeSync adaptive sync technology.

The 31.5-inch Acer Predator XB323QK NV display features an IPS panel that covers 90 percent of the DCI-P3 color gamut and comes with a VESA DisplayHDR 400 certification. Those 400 nits don't offer the sort of contrast ratio you'd expect from a proper HDR television, where 1000 nits is the standard, but it should be a pleasurably bright display—and 1000-nit PC displays are very rare and tend to be significantly more expensive. This monitor is also certified by Nvidia as being G-Sync Compatible. That essentially means it's a FreeSync panel that has passed Nvidia's more stringent evaluation. The adaptive sync will work with GeForce graphics cards out of the box rather than needing to be enabled manually.

The Acer Predator XB323QK NV will cost $1,200 when it launches in May.

Finally, the Acer Nitro XV282K KV opts for FreeSync Premium instead. It also comes with an HDMI 2.1 port to easily allow next-gen gaming consoles to connect to the IPS display and still enjoy the buttery smoothness of variable refresh rates. It'll start at $900 when it launches in May.

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IMAGE: MICROSOFT

Microsoft will shut down Minecraft Earth in June

Microsoft cited the lack of free movement and collaborative play caused by pandemic lockdowns as the reason it's closing its AR version of Minecraft. **BY MARK HACHMAN**

Microsoft will be shutting down its augmented-reality version of Minecraft, known as *Minecraft Earth*, beginning in June 2021, the company said on Tuesday, January 5. Microsoft blamed the pandemic as a cause, as well as the lack of freedom of movement that the game required.

At its core, *Minecraft Earth* was a game based upon exploration and discovery. During the early days of lockdown, my kids and I would wander around the neighborhood, looking for animals, ores, and dungeons to explore. But Microsoft said that the "current global situation" prevented the free movement and collaborative play that allowed *Minecraft Earth* to survive.

As a result, *Minecraft Earth* will be turned off in June. "On June 30, we will discontinue all content and service support for the game," Microsoft said in a blog post (go.pcworld.com/shdn). "This means that we will stop all development, and after that date, you will be unable to download or play *Minecraft Earth* anymore. On July 1, we will delete any *Minecraft Earth* player data unrelated to

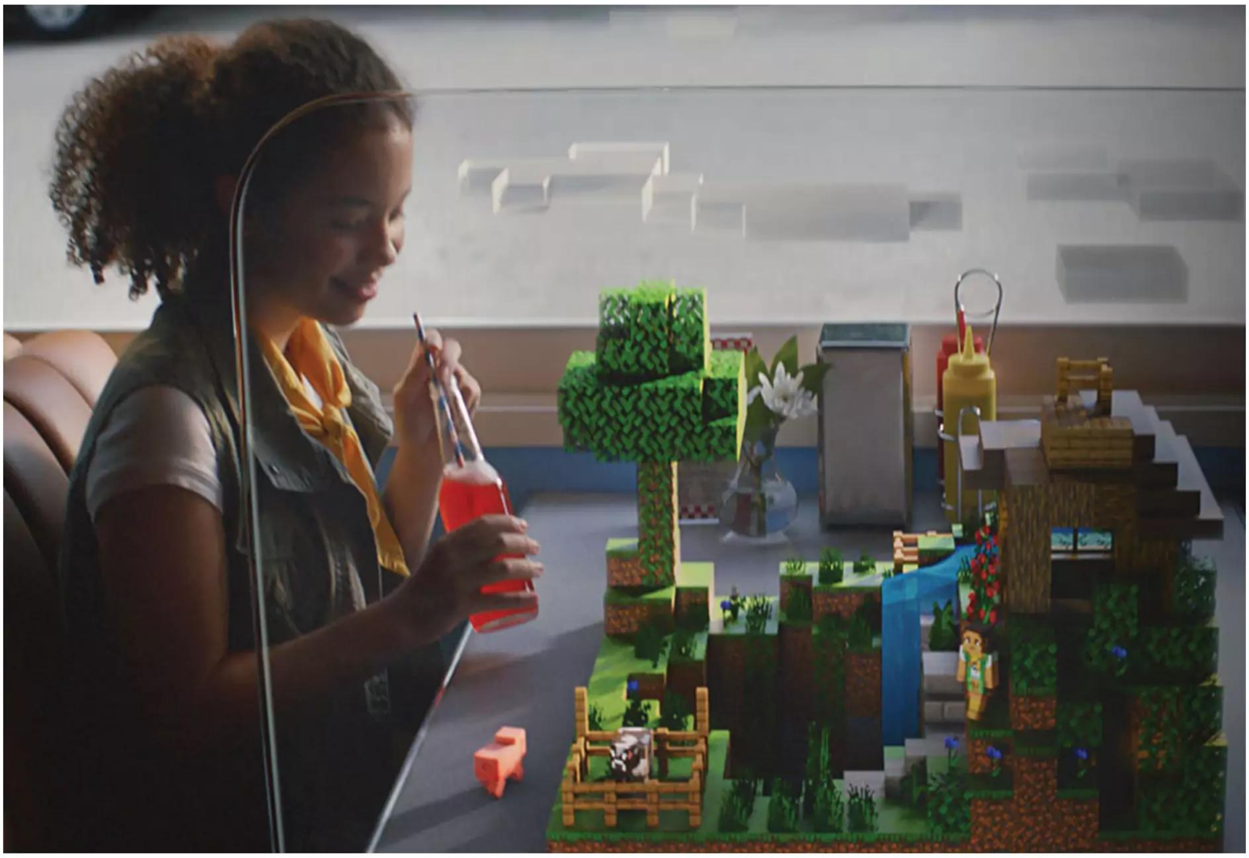
Character Creator and Minecoin entitlements."

However, Microsoft released its final update to *Minecraft Earth* on the same day as the shut-down announcement. The final update releases all of the content that Microsoft had planned for the game and had completed, and removes real-world money transactions entirely. If you have made a purchase in *Minecraft Earth*, however, you'll be gifted with a free version of the Bedrock version of *Minecraft* (which you probably own already). All players with paid "ruby balances" will be granted Minecoins, which you can use on the Minecraft Marketplace to purchase skin and texture packs, maps, and even minigames.

The final update also includes:

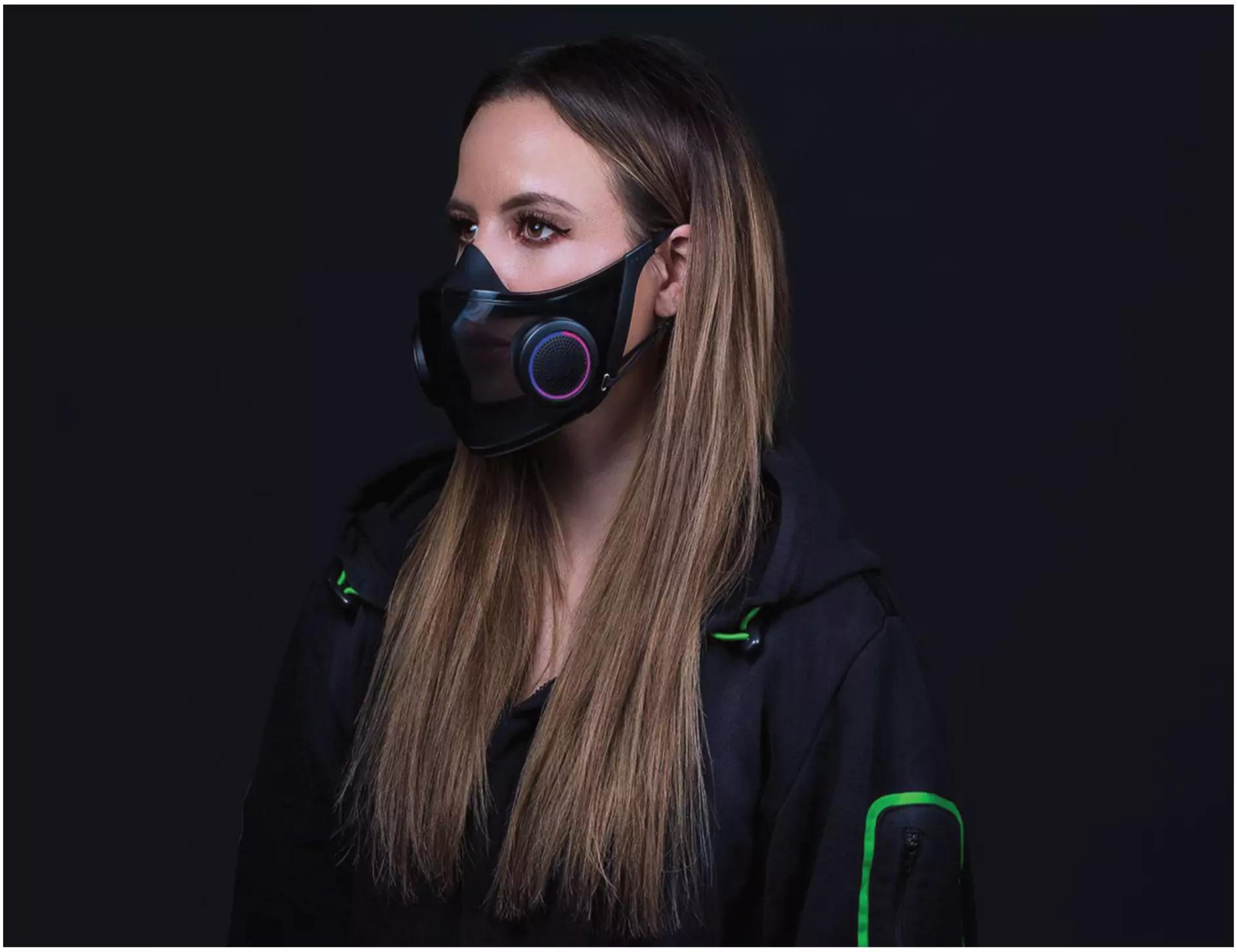
- Drastically reduced ruby costs
- Reduced time requirements for crafting and smelting
- Replacement of unused crafting & smelting boosts with radius boosts of the same level
- A set of Character Creator items granted to players who sign in between January 5 and June 30

"We're eternally grateful for the amazing talent in the *Minecraft* community," Microsoft wrote." This was not an easy decision, and we're doing everything we can to make sure you get the most out of *Minecraft Earth* before it sunsets."



Razer is bringing RGB to N95 masks, because why not?

In addition to the Razer Project Hazel N95 mask, the company also demonstrated Project Brooklyn, a concept gaming chair with a retractable screen. **BY MARK HACHMAN**



Masks to prevent the spread of COVID-19 have evolved from protection to a fashion statement. Now Razer is taking it a step further with Project Hazel, a voice-amplified RGB mask it announced at CES 2021. Yes, RGB.

In March 2020, Razer announced that it would convert some of its manufacturing lines to develop certified surgical-grade masks (go.pcworld.com/mlmk) to help fight the spread of coronavirus, and company executives said they've already manufactured a million masks. "And as a natural progression, the evolution of this initiative, we wanted to test our team with looking at developing a new mask,

IMAGE: RAZER

something designed from the ground up for the new normal," said Mike Scharnikow, a senior marketing manager at Razer.

That mask is known as Project Hazel, a prototype that Razer hasn't definitely committed to manufacture quite yet—but does have prototypes that were shown on a Razer presentation livestreamed from CES. Scharnikow called it "the world's smartest mask," one designed to address the increased emphasis on hygiene and the environmental issues of disposing masks, while also enhancing the features of a multi-use personal face covering.

THE CONCEPT DESIGN FOR NEXT GENERATION
IMMERSION IN A GAMING CHAIR

Razer's Project Brooklyn gaming chair.

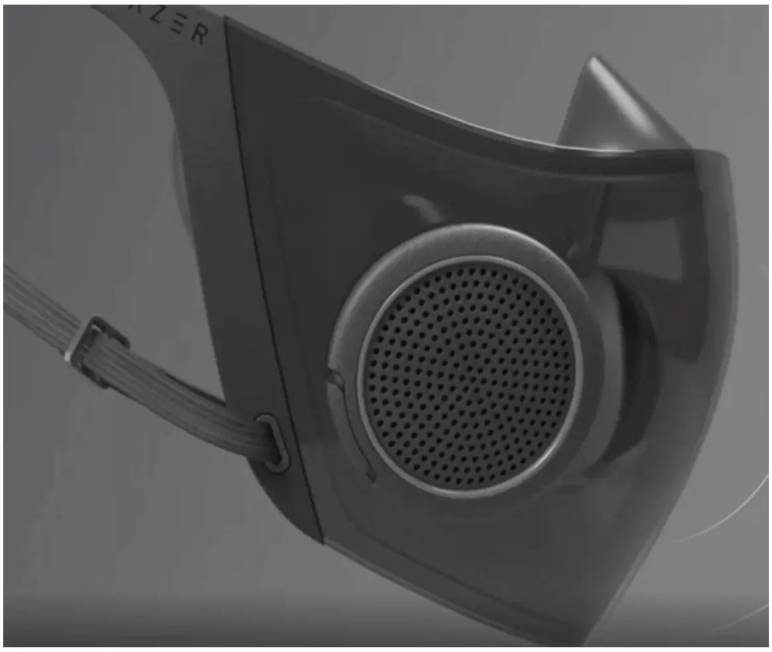
Razer also showed off Project Brooklyn, a conceptual gaming chair with a retractable panoramic screen that folds back into the chair itself. The chair features a tray to hold a console or a laptop, as well as cubbies built into the armrest to hold peripherals.

PROJECT HAZEL: RAZER'S RGB N95 MASK FOR THE NEW NORMAL

The recyclable Project Hazel mask features a transparent external face shield as well as a flexible silicone lining that conforms to the user's face and mouth. On each side of the face, a pair of replaceable N95 "smart pods" will provide filtration capabilities. Razer designed the vents as an active ventilation systems, with the ability to control the airflow in and out of the mask, Scharnikow said.

And it's the transparent face shield that points to one of the problems that Razer is trying to solve: the limits on social interaction of wearing a mask. The transparent face shield was designed to allow people you're talking with to be able to see your facial expression, as well as to allow those who can read lips to be able to see your mouth. Razer has also gone further: *inside* the mask, subtle LED lights illuminate your mouth at night, too.

Did Razer stop there? Oh no. "One of the biggest issues we also know beyond the visual piece with wearing a mask is the muffled talking and the limits on communication this creates," Scharnikow



A closeup of Project Hazel's N95 filters.

said. So Hazel includes a low-latency mic and speaker array that detects your voice, then uses the speaker array to project your voice out naturally into the world. The voice algorithm can be trained via an app that Razer will include, and it makes it sound exactly how you would without the mask, he said.

Yes, Project Hazel will have RGB, which appears as small rings around the filters whose colors can be changed. The RGB LED rings are both practical *and* aesthetic; they'll communicate the mask's status, or if the LEDs themselves need to be charged. And, of course, users will likely be able to use Razer's app to adjust the color, too.

Naturally, the Project Hazel mask *will* need to be charged. Razer designed a combination charging case that both can charge the mask overnight as well as sterilize via UV light. It's not clear how long the mask's charge will last (or if it could be used passively, even without a charged battery), how comfortable the mask would be to wear over long periods, and so on. But, c'mon: the future of masks could be glowing, rotating mask filters that you could wear to an (outdoor, distanced) rave and about town. What's not to like about that?

Razer's Project Hazel mask and its charging station.

In 30 states, it's legal to fire, evict or deny service to LGBT people.

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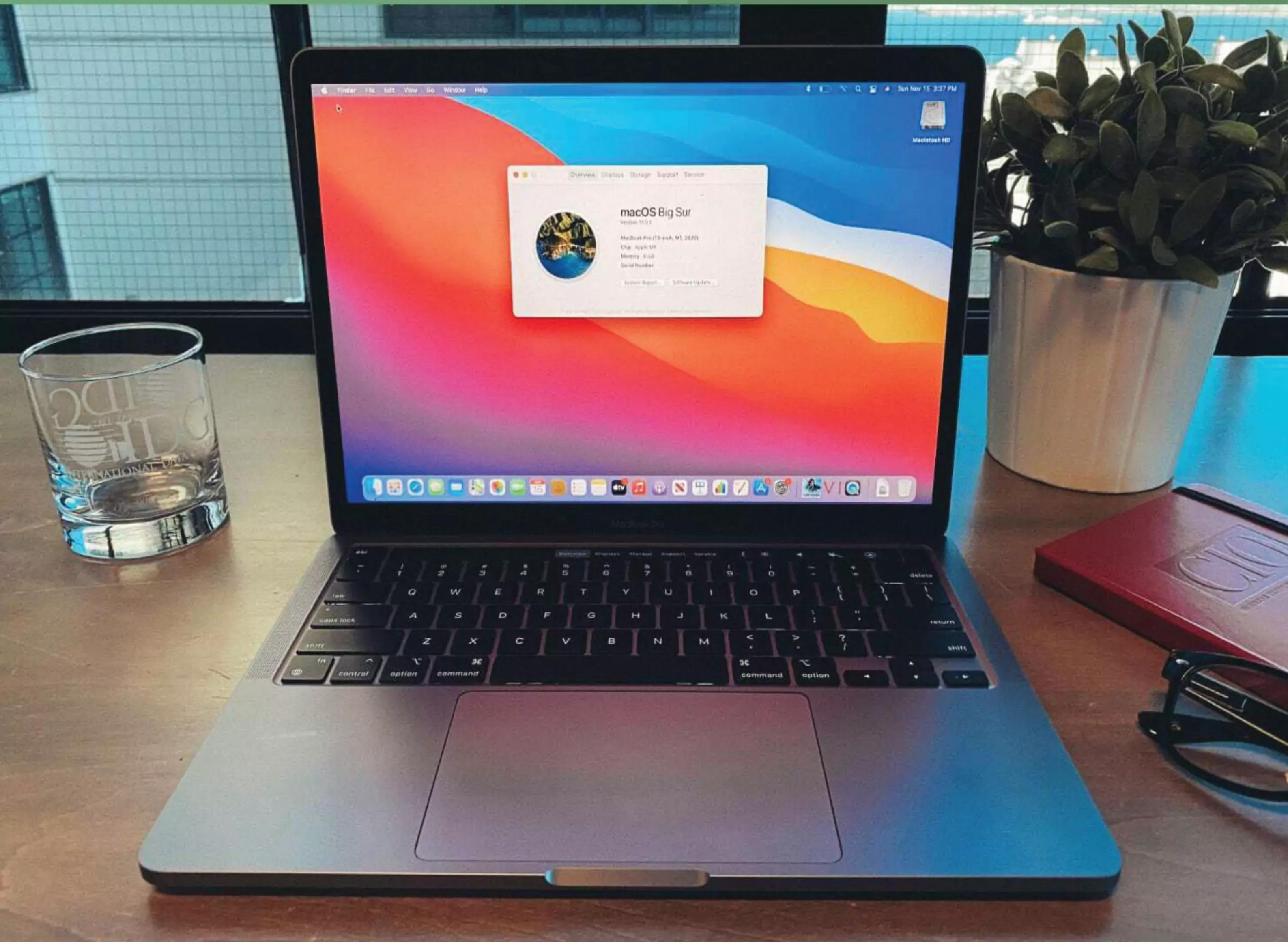


Tested: How Apple's M1 chip performs against Intel 11th-gen and AMD Ryzen 4000

We put the PC's best laptops against MacBook Pro M1 to see if Apple's new ARM chip really is all that. **BY GORDON MAH UNG**

Apple's new M1 processor took the laptop world by storm, with many proclaiming it had ended the PC's whole career (go.pcworld.com/enpc).

Hyperbole and irrational fanboy flexing aside, Apple's M1 is indeed a powerful chip. But to get a better feel against its contemporaries we sat down and retested a pile of current Windows 10 laptops to get an

IMAGE: IDG

idea where the M1 MacBook Air 13 lands in the pecking order of laptops.

While we don't have direct access to an MacBook Pro M1, our sister publication, Macworld does, so we cribbed from its glowing review of the 13-inch MacBook Pro M1 (go.pcworld.com/glrv). Macworld also graciously ran a couple of additional tests for our analysis. For two other results, we relied on published results from Puget Systems (go.pcworld.com/pgsm), a bespoke system builder that manufactures workstations and rolls its own productivity-focused benchmarks.

Our tests show the M1 MacBook Air 13 performing very well compared to equivalent PC laptops. You can jump straight to our conclusion for the final analysis, but if you want to dig deeper to see exactly where and how the M1 does well, read on…

The MacBook Pro M1 features Apple's M1 Arm-based SoC/CPU.

THE LAPTOPS WE TESTED

Apple's MacBook Pro M1 features its spiffy new M1 Arm-based SoC/CPU, a 512GB custom SSD, 16GB of LPDDR4X/4267 memory, a 13.3-inch 2560x1600 screen, and lap weight of 3.1 lbs.

For our PC comparisons, we decided to pick from laptops that are similar in size and weight:

- MSI's Prestige 14 Evo (go.pcworld.com/14ev) is equipped with a four-core, 11th-gen Core i7-1185G7 with Iris Xe graphics, 16GB of LPDDR4X/4267 memory, a 512GB PCIe Gen 4 SSD, and a 14-inch FHD screen. It weighs 2.7 lbs.
- MSI's older Prestige 14 (go.pcworld.com/ps14) is equipped with a six-core, 10th-gen Core i7-10710U, GeForce GTX 1650 Max-Q graphics, 16GB of LPDDR3/2133 memory, a 1TB PCIe 3.0 SSD, and a 14-inch 4K screen. It weighs 2.8 lbs.
- Lenovo's Yoga Slim 7 (go.pcworld.com/slm7) has an eight-core Ryzen 4800U with Radeon graphics, 16GB of LPDDR4X/4267 memory, a 512GB PCIe 3.0 SSD, a 14-inch FHD, and lap weight of 3.1 lbs.
- The Asus ROG Zephyrus G14 (go.pcworld.com/az14) includes an eight-core Ryzen 9 4800HS, GeForce RTX 2060 Max-Q graphics, 16GB of DDR4/3200 memory, a 1TB PCIe 3.0 SSD, a

14-inch FHD screen, and a weight of 3.6 lbs.

Before you object to having the Zephyrus G14 laptop here, pay close attention to the weight and size of the laptop. At 3.6 lbs., it's actually very close to the weight of the Lenovo Yoga Slim 7 and the Apple MacBook Pro 13, which are each 3.1 lbs. We think there are indeed some people who might consider the Zephyrus G14 to get the extra power its GeForce RTX 2060 Max-Q provides. Yes, the 180 watt power brick adds even more weight to the G14, but it may just be worth it to those folks.

ROG ZEPHYRUS

We compared Apple's MacBook Pro M1 to a number of similar laptops, including the Asus ROG Zephyrus G14 (pictured here).

We think discrete graphics are one of the overlooked features of the older MSI Prestige 14 too—a laptop that weighs less than the Lenovo Slim 7 and MacBook Pro M1, but features a GeForce GTX 1650 Max-Q GPU inside. There are indeed several compromises in the older Prestige 14 to get that GPU, which we detailed in our original review (go.pcworld.com/14rv), but weight is typically the great equalizer.

That's why the final laptop we included is really there for a raw performance comparison, since no one would consider it remotely in the class of the laptops above:

- The Acer Predator Triton 500 (go.pcworld.com/trt5) with a six-core 10th-gen Core i7-10750H CPU, GeForce RTX 2080 Super graphics, 32GB of DDR4/3200 memory, a 1TB PCIe 3.0 SSD, and a 15.6-inch 300Hz FHD screen. It weighs 4.6 lbs.

We wanted this laptop particularly for its Core i7-10750H CPU, which is very similar to Intel's 8th-gen and 9th-gen "H" class CPUs found larger laptops such as Apple's MacBook Pro 16 (go.pcworld.com/ap16). Most of the laptops here feature lower-power CPUs, so we wanted to see just how well the M1 and other chips in smaller laptops compared against a chip that sucks down many more watts.

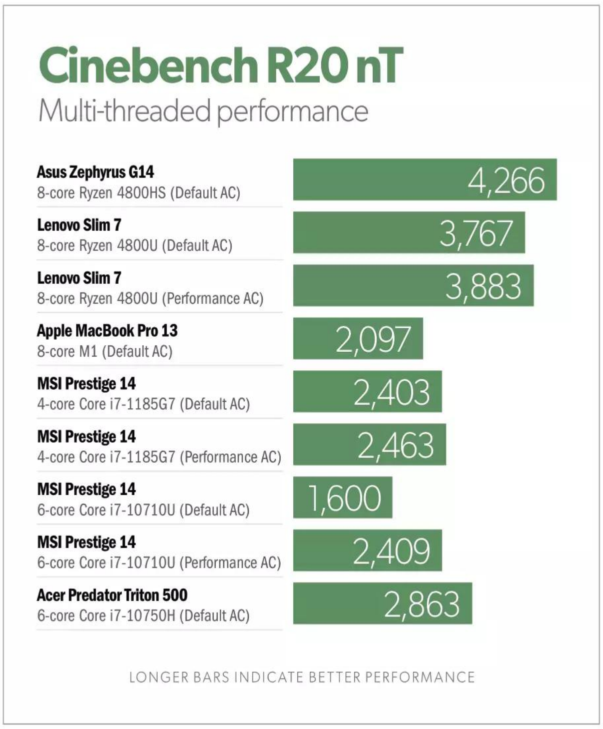
Of all of the chips here, Apple's M1 uses TSMC's most advanced 5nm process, with the two Ryzen laptops using TSMC's 7nm. Intel's 11th-gen "Tiger Lake" Core i7-1185G7 is on Intel's newest 10nm process, while the Core i7-10710U is like the Core i7-10750H and built on Intel's—how can we say this politely?—wise 14nm process.

CINEBENCH R20 PERFORMANCE

We'll kick off our results with Maxon's older Cinebench R20. It's a 3D modelling benchmark built on the company's in-house engine used in its commercial Cinema4D product. Cinebench R20 had versions for x86 on Windows and x86 on MacOS. Maxon's newer Cinema R23 offers native support for Apple's M1 chip, but the older R20 version must use Apple's Rosetta 2 (go.pcworld.com/rsta), a technology that handles just-in-time translation of x86 instructions to Arm from non-native code.

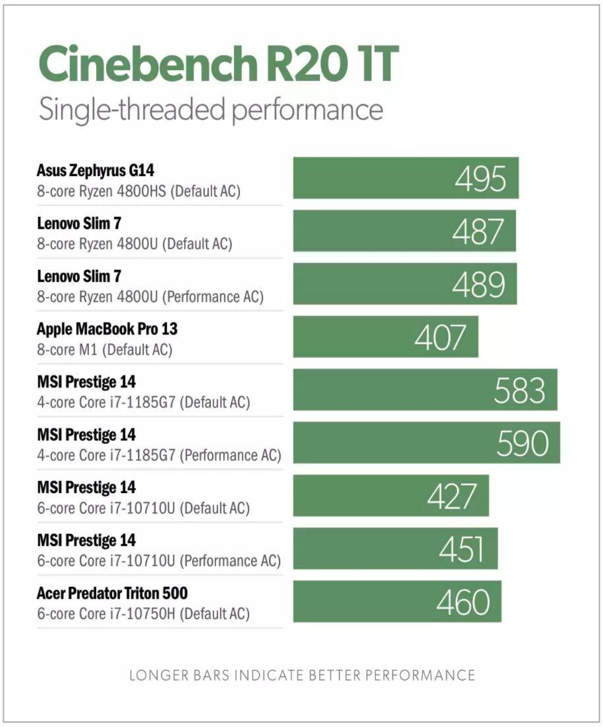
Having to pay a real-time translation penalty typically blows chunks so we expected the M1 to cough up furballs, but it's well-known now that Apple's unlimited funding and hard work has paid off handsomely. Yes, you can look at the black bar in the chart and see that the red Ryzen 4000 chipsstomps the M1 into the ground. And yes, the quad-core Core i7-1185G7 is faster too, despite the Mac have eight physical cores, but remember the translation penalty the MacBook is paying and how much it saps performance. This is an impressive showing by Apple.

Cinebench allows you to measure a


Cinebench R20 nT

Multi-threaded performance

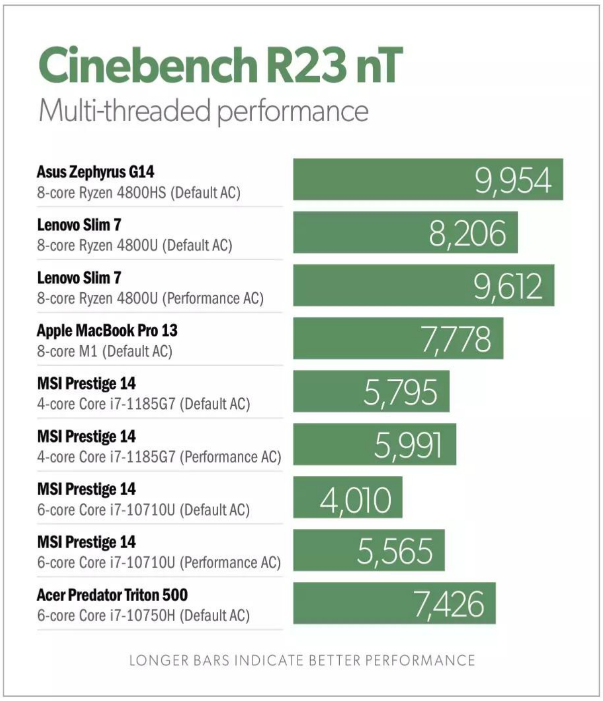
LONGER BARS INDICATE BETTER PERFORMANCE


Cinebench R20 1T

Single-threaded performance

LONGER BARS INDICATE BETTER PERFORMANCE

single-threaded performance as well. For the x86 side, where Ryzen previously beat Core, it's now flipped as we see Intel's new 11th-gen Core i7-1185G7 leading the way. The Apple MacBook Pro M1? It's really not bad again when you consider that Apple is paying a hefty translation penalty. Some believe it to be as high as 30 percent, which coincidentally is matches the fee Apple takes from App Store purchases, sparking its war with Epic. We don't know if the two are related, but we'd guess the M1 picks up a lot more mileage with native code.

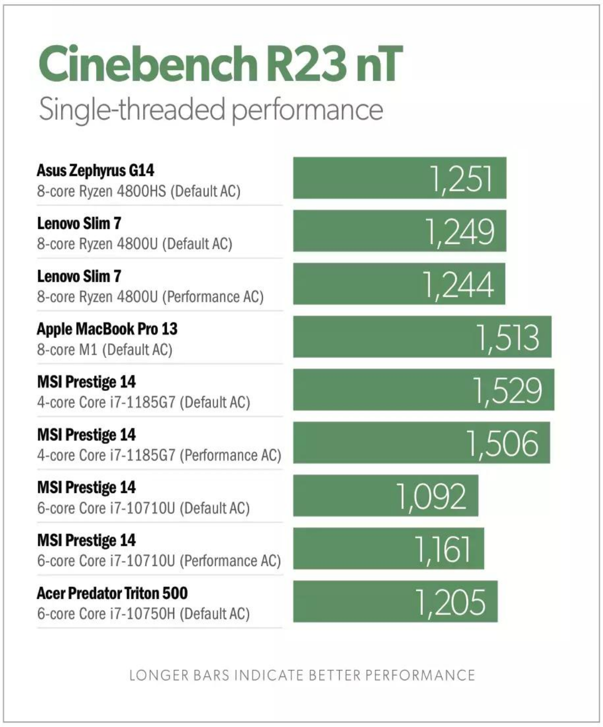

Cinebench R23 nT
Multi-threaded performance

LONGER BARS INDICATE BETTER PERFORMANCE

CINEBENCH R23 PERFORMANCE

Maxon released a new version of Cinebench R23 with native M1 support, but there are some other key changes which should be mentioned as well. With Cinebench R20, the benchmark would run render a single scene and produce a score based on its completion. With Cinebench R23, the render scene is the same, but Maxon has interestingly changed it to render the same scene over and over for 10 minutes. The benchmark will even run beyond 10 minutes if the scene is still rendering when the timer hits zero.

On a six-core Intel H-class chip, Cinebench R15 takes 34 seconds to complete while Cinebench R20 takes about 108 seconds. With Cinebench R23 it now takes a minimum of 600 seconds to run under the new method. On a desktop or workstation with far more cooling it's not an issue, but on laptops an all-core test that runs for at least 10 minutes can be far harsher—especially on CPUs that either make more heat, or laptops


Cinebench R23 nT
Single-threaded performance

LONGER BARS INDICATE BETTER PERFORMANCE

with more limited cooling. It's actually called a "throttle test" which is a different method than before for Cinebench.

None of this bothers Apple's M1 much though. Based on TSMC's most advanced 5nm process, it's a stone cold killer, with Macworld reporting no fan noise at all during the run. That can't be said of the x86 laptops, which all vary from fairly quiet to a little rackety.

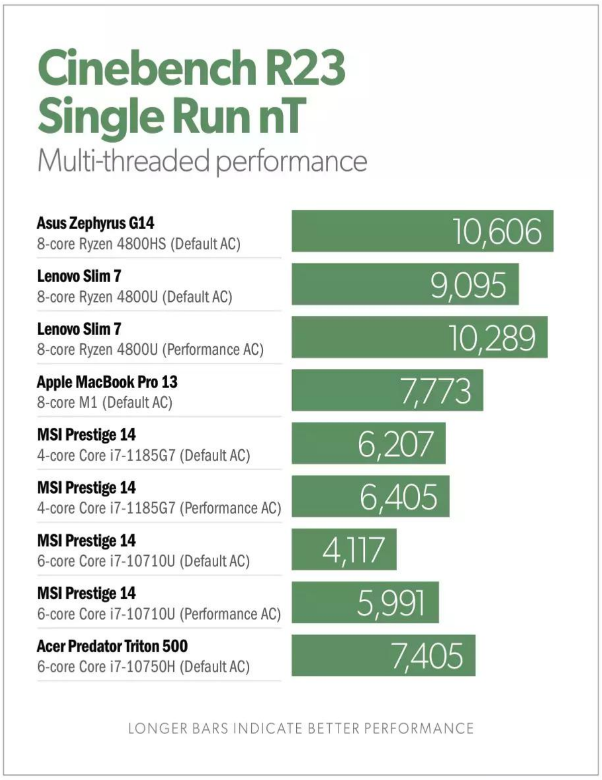
The performance is impressive though, with the eight-core M1 Mac now ahead of the four-core 11th-gen Tiger Lake as well as the older six-core Core i7-10710U. But if you give Intel's older six-core more thermal head room it's almost dead even with the silent M1. An eight-core variant of an Intel H-chip would be even faster obviously.

AMD, however, just shrugs at all this and yawns as its eight-core Ryzen 4000 chips easily beat all comers when set to their performance modes.

Single-threaded performance probably matters more for what most people do and the M1 doesn't disappoint there either. Neither does Intel's Core i7-1185G7, to be fair. Its single-threaded prowess has pushed aside Ryzen 4000 and you see that here where both the M1 and the Core i7-1185G7 are basically tied in Cinebench R23. There's some conjecture that "we're just not testing x86 right" as Usman Pirzada argues at WCCFtech (go.pcworld.com/uman). However, Joel Hruska at Extremetech (go.pcworld.com/xtch; who worked on the results with Usman) argues the ball is really back in Intel and AMD's court for how to address the limitations.

The main take away is the single-threaded performance on the M1 as well as Intel's Tiger Lake is nothing to dismiss.

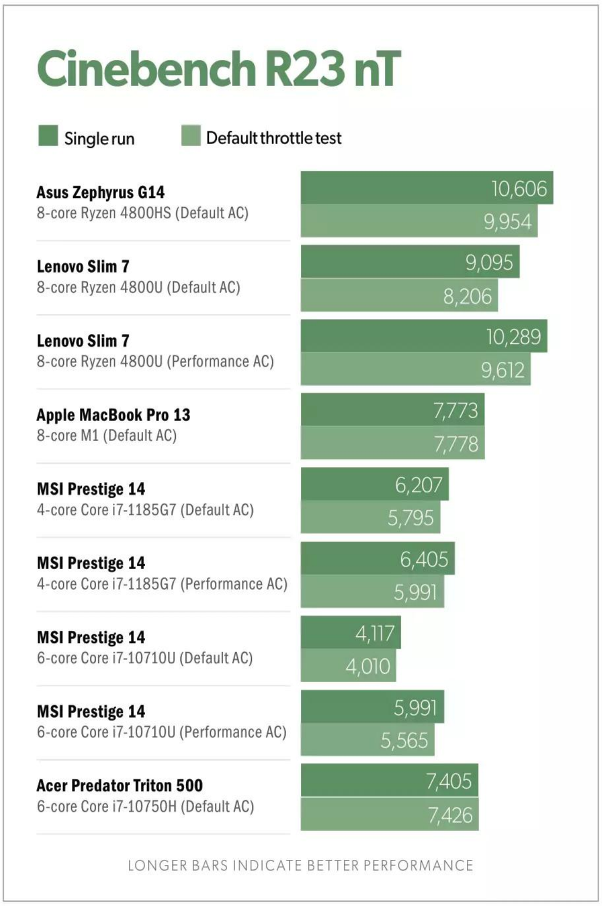
But as we said, there is indeed a cost to be had for when you run every CPU core that hard on a laptop. Cinebench R23 allows you to actually turn off the "Throttle Test," so we did that to record scores of Cinebench R23's multi-core benchmark in a more traditional single render scene. Laptops that can benefit from only running full tilt for three minutes versus more than 10 minutes get a decent 6 to 8 percent boost. The Ryzen 4000 laptops actually open up their performance gap



against The M1 and Intel chips even further when the run time is reduced.

This just goes to show you the boosty nature of laptops improves from lowering the thermal load, putting in more fans to dissipate that thermal load, or simply making your CPU more efficient.

You can see that in the next chart, where we took our Cinebench R23 single-run result and compared it to the result of Cinebench R23 in its default throttle test. The laptops that face more of a thermal limit all show 6 to 8 percent improvement when the load is cut by two-thirds, except for two: The Apple MacBook Pro M1 and the Acer Predator Triton 500.



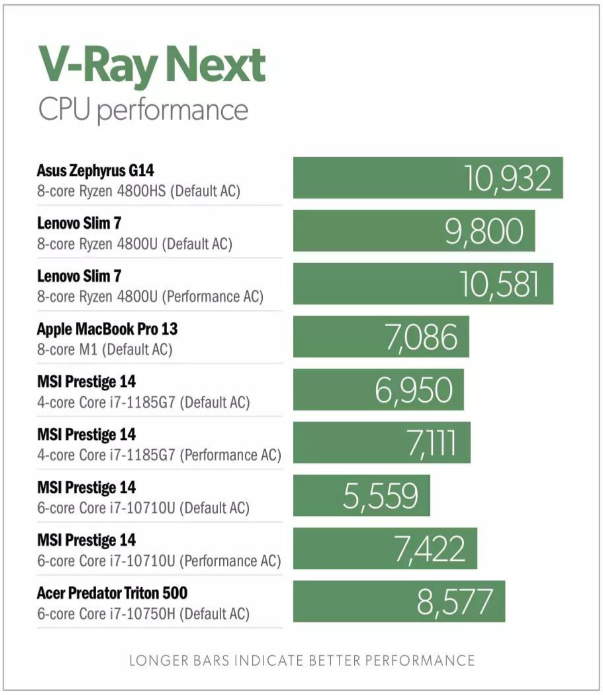
In the Predator Triton 500's case, its larger chassis, additional heat pipes and additional venting means the CPU is just never generating enough heat to hit that thermal wall, even with a fairly high-wattage Intel chip inside. Its six cores of 14nm oldness still can't outpace the other chips, but the thermals clearly have no issues. That shouldn't surprise, as the Triton 500's cooling was designed to keep the GeForce RTX 2080 Super Max-Q running smooth as well, so running a pure CPU load means the cooling headroom is far higher.

The MacBook Pro M1 is equally impressive for a different reason. Despite being a thin and light laptop, it just doesn't seem to generate enough heat to hurt it. You can run Cinebench R23 for 3 minutes or 10 minutes—it just doesn't care. That's something that should be appreciated.

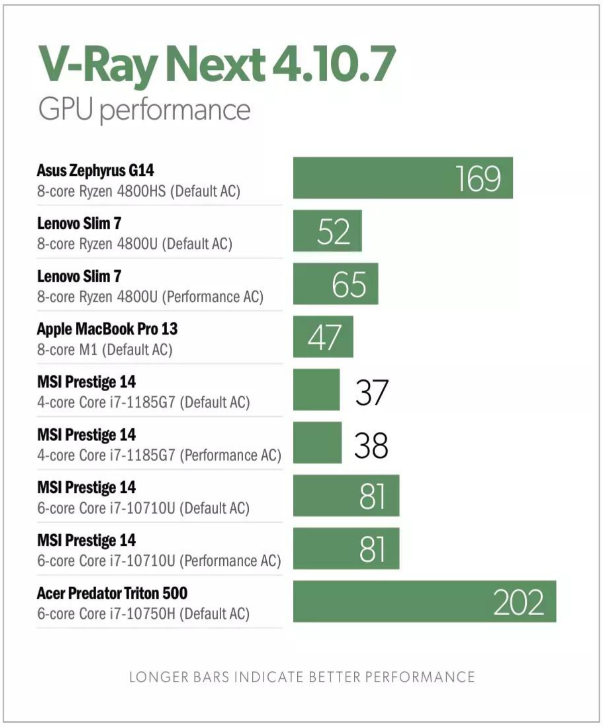
And yes, the older Prestige 14 with its 14nm Comet Lake U chip on its default setting basically doesn't move much because on default, it's probably so lackadaisical it doesn't matter anyway. It also benefits from cutting the render time down on its performance setting though.

V-RAY NEXT PERFORMANCE

Up next is Chaos Groups' V-Ray Next benchmark, another 3D rendering test. Like Cinebench R20, it's non-native to the new MacBook and loves more cores. With the



M1's translation tax, V-Ray Next loses some performance, but it's still enough to just about equal Intel's four-core Tiger Lake part. AMD and its eight-core Ryzen CPUs again gives all others a good Nelson Muntz laugh.



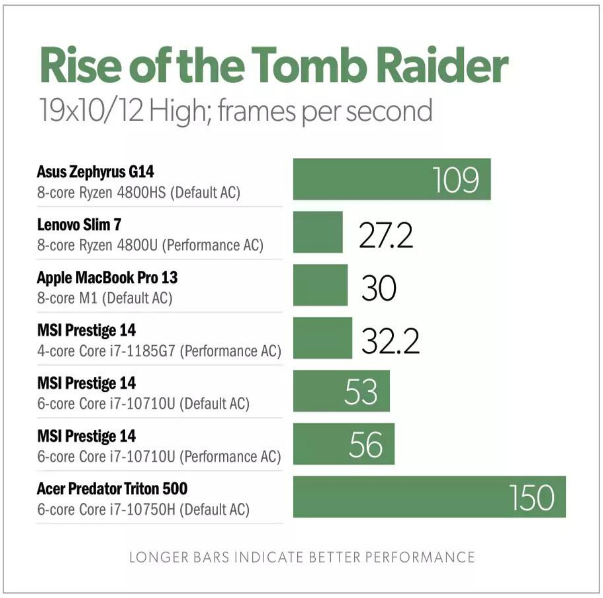
V-Ray allows you to also run a render on the GPU instead, which is increasingly popular among advanced engines. Of the chips with onboard graphics, the Ryzen 7's Radeon GPU cores put AMD in front, Apple's M1 falls in the middle, and Intel lags a bit behind.

GPU rendering performance, obviously, gets better with more powerful GPUs. The GeForce RTX 2080 Super Max-Q in the Triton 500 thus wipes the floor with everyone else, while the GeForce RTX 2060 Max-Q doesn't do too shabby either. This, frankly, is one of the reasons we think the Asus G14 is still so compelling. Its 0.5-lbs heavier than the laptops with onboard graphics but that GeForce RTX 2060 Max-Q makes a yuge difference in performance.

RISE OF THE TOMB RAIDER PERFORMANCE

We used just one game to look at the graphics performance of the M1 compared to Windows laptops. We ran *Rise of the Tomb Raider* set to 1920x1080 on the Windows laptops on high and compared it to the result *Macworld* got on the MacBook Pro M1 running at 1920x1200 on High.

While the integrated graphics in Intel 11th-gen laptop is in front of AMD and Apple's onboard GPUs, let's just call it a tie and agree all three would be capable of moderate gaming at lower resolutions. Less intense



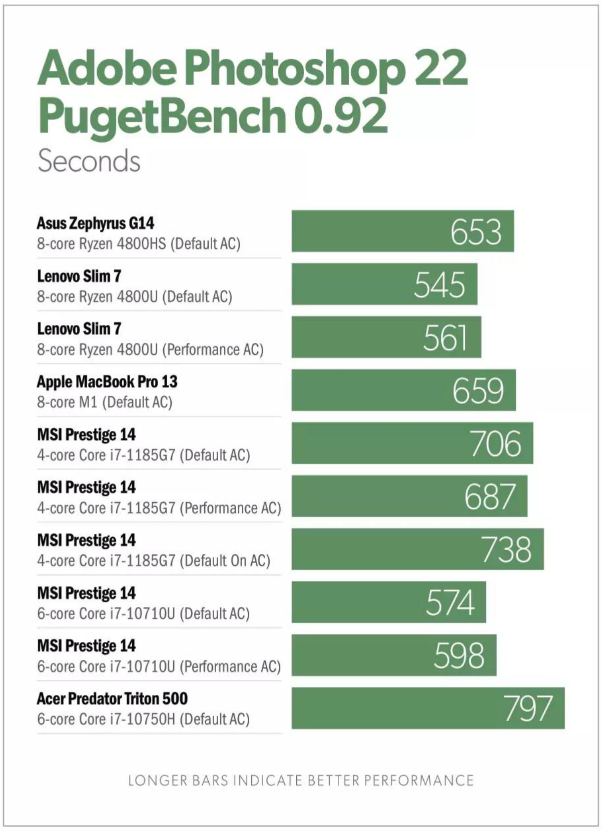
games would be easier of course. None of them would compare to a laptop with a discrete GPU though. As you can see, the GeForce GTX 1650 Max-Q walks away from the integrated graphics laptops, and we'll remind you again the Prestige 14 with the GTX 1650 inside weighs less than two of the other laptops.

Of course, we can't ignore that Asus Zephyrus G14 nor the Predator Triton 500 either. If you really intend to do anything graphically intense, get a laptop with discrete graphics in it.

Still, the three integrated graphics laptops do fairly well. We wouldn't even bother trying to compare to laptops with Intel's UHD graphics. Focusing on the MacBook M1, it again offers very impressive performance. But yes, if someone is going to squawk at you about its graphics performance, pretty much any Windows laptop with half-decent discrete graphics will eat its lunch, and for less money. We're pretty certain that a budget Black Friday gaming laptop sold for $700 is likely to whoop the MacBook Pro M1 in games thanks to its discrete graphics chip. And no, we can't run *Counter Strike: Global Operations* or *Red Dead Redemption II* on the new MacBook Pro M1. You know why so don't ask.

PUGETBENCH PHOTOSHOP PERFORMANCE

All this talk of 3D rendering, single-threaded performance and blah, blah tests probably sound like what your dog hears when you scold him for pooping on the new carpet. In real life, people use these things called applications. Among the most popular is



Adobe's Photoshop.

To test its performance, we used Puget Systems' PugetBench, which is where we also sourced the M1 performance results. Puget Systems looked at the M1's performance (go.pcworld.com/psm1) to help people have a clearer understanding of where the new MacBook Pro M1 stands in relation to desktop performance (which will always be faster). Despite the flexing from Mac super fans, even an old desktop PC is faster than the MacBook Pro M1, as Puget Systems found.

Comparing it against contemporary laptops, though, shows the M1 does quite well with performance, surpassing the Lenovo Yoga Slim 7 and its Ryzen 7 4800U chip. It's about tied with the Ryzen 9 4900HS in the Zephyrus 14 too. Photoshop has traditionally been very single-threaded, so we're not too surprised to best honest. Single-threaded CPU performance never really was Ryzen 4000's strength. Intel's 11th-gen Tiger Lake chip is in front of the MacBook Pro M1 by a small amount.

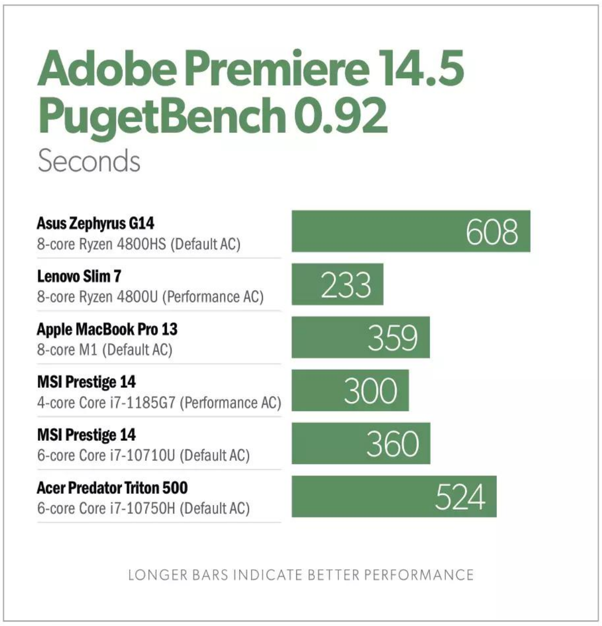
Also of interest are the results from two older 14nm-based Intel laptops. The Prestige 14 with its GeForce GTX 1650 Max-Q and very boost-limited high clocks doesn't quite pay off the dividends you'd expect, so we really think the test makes far sparser use of the discrete GPU than you might think.

What doesn't disappoint though is that relatively large Acer Predator Triton 500. It's the overall winner. We attribute that to its far better cooling, which enables higher-clock speeds; possibly its GeForce RTX 2080 Super Max-Q GPU; and, crucially, its 32GB of base memory. Intense Photoshop users should always opt for as much memory as you can pack into a laptop.

PUGETBENCH PREMIERE PERFORMANCE

Moving on to something far stiffer, we also used PugetBench Premiere on the laptops. Since the test takes over an hour and requires as much performance as you can get, we've decided to limit it only to the laptops in their respective performance modes. Against laptops with integrated graphics—the Ryzen 4000 Slim 7 and the 11th-gen Prestige 14 Evo—it's a win for the MacBook Pro M1. More so against the Slim 7, which falls behind further than expected.

Laptops with discrete graphics fare better,



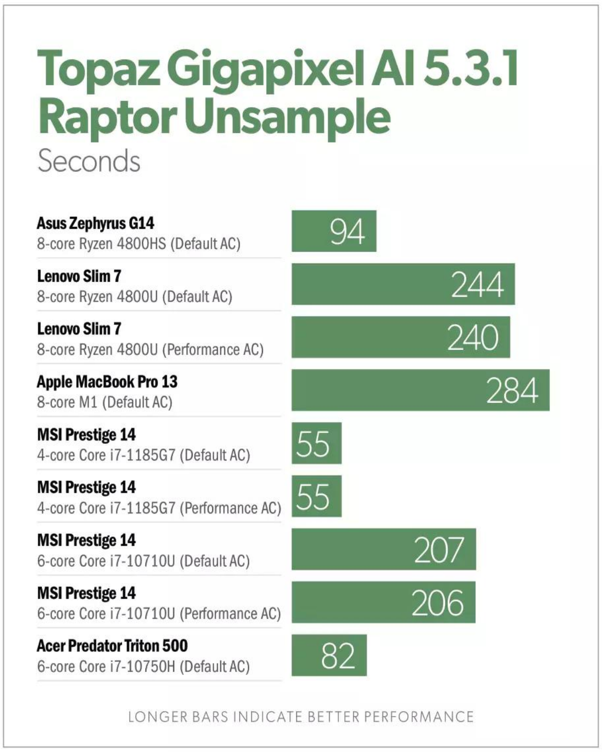
with the GeForce GTX 1650 Max-Q in the older MSI Prestige 14 pulling even with Apple's M1. The GeForce RTX 2080 Max-Q in the Acer Predator Triton 500 has no problems leaving the smaller laptops far behind though. The compact Asus ROG Zephyrus G14 with its 8-core Ryzen 9 and GeForce RTX 2060 Max-Q which dusts off all comers.

This probably indicates that GPU encoding capabilities matter for how PugetBench sets its test up. When balanced with a multi-core chip, it's a winning combination overall. Still, it's a good showing for the M1 Mac, but realistically, it's probably going to be slower than a budget gaming laptop in many Premiere tasks.

The big question is how much of a boost the M1 gets once Adobe offers native support in its apps. Since Adobe's products are so vast and what people do are so varied, it's pretty hard to say if the native performance boost will be as large as we see in Cinebench. There are just so many things being touched. We *can* say there will indeed a performance bump—but nobody knows how big it will be.

TOPAZ GIGAPIXEL AI PERFORMANCE

One more chore we wanted to throw at the laptops uses advanced AI features. We find that in Topaz Lab's Gigapixel AI (go.pcworld.com/tpaz) application, which uses machine learning models to upsample images in a method that can be far more effective than traditional enlargement techniques.



For our test, we took an image of a US Air Force F-22 Raptor shot in 2010 on an 8.2MP Canon EOS 1D Mk IIn DSLR. We feed the image into Gigapixel AI and task it with increasing the resolution by 6x. The application uses Intel's OpenVINO framework and is quite impressive—on Intel hardware. Since Macs up until now have been based on Intel, that's been a plus for the many Topaz Labs customers.

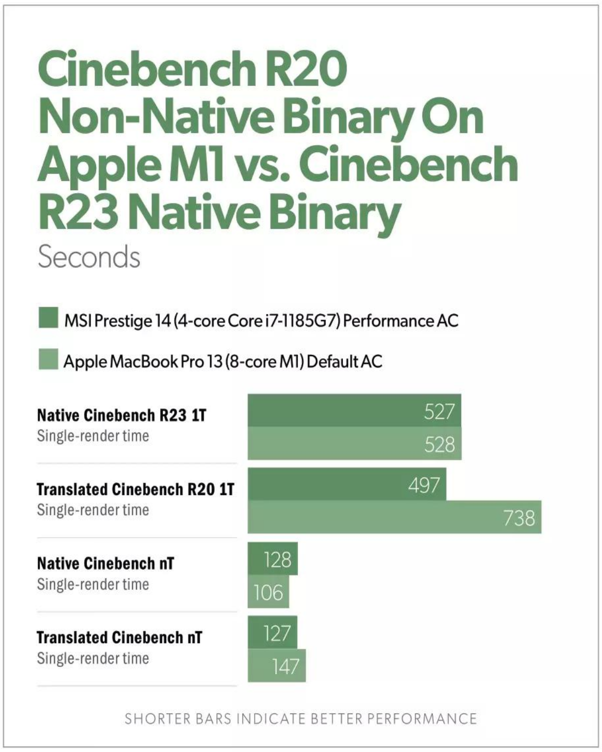
Macworld ran the same build of the app on the MacBook Pro M1 with the same settings that we used on our Windows 10 machines. If you read our 11th-gen Tiger Lake preview (go.pcworld.com/tgel), you know that Intel's new-look CPU rocks the Ryzen 4000 chip. It's fair to say that it's a slaughter for the Slim 7 laptop with its Ryzen 7 4800U. The 11th-gen Tiger Lake chip also easily runs its 14nm sibling in older Prestige 14 off the field.

And yes, the MacBook Pro M1 performs the worst of all of the laptops here. We're talking about 1 minute for the 11th-gen Intel chip in the MSI Prestige 14 Evo versus just under 5 minutes for the MacBook Pro M1. That's for just a single image, too.

Gigapixel AI also supports discrete graphics, which actually helps the Zephyrus 14 and Predator Triton 500 stay in the game. But even with their much faster discrete GPUs they're still significantly slower than the 11th Tiger Lake chip.

In the past, AMD would throw it back in our face by saying that such specialty apps are used by far, far fewer people than even 3D modelling or a video encoder. We suspect Apple fans would say the same thing—and imply that once Gigapixel AI is updated to support the MacBook M1 and its own inference engines, the M1 will far better.

In a perfect world, yes, but we really don't know if or how long that will take. We should also point out this is a real application being used by an untold number of photographers and digital artists.


Cinebench R20 Non-Native Binary On Apple M1 vs. Cinebench R23 Native Binary

Seconds

APPLE M1 ROSETTA 2 COST

There have been plenty measurements of the translation cost needed to make x86 apps run on the MacBook M1, but we wanted to take yet another stab it. For that we decided to use Cinebench R23 and Cinebench R20. As we said earlier, R20 is native to Intel-based Macs, while Cinebench R23 is not. Cinebench R20 bases its score on a single render, while Cinebench R32 bases it on multiple renders by default. To see if they compare, we timed how long it takes to run a single render in both versions. On the Windows version, it's within the margin of stop watch error on the MSI Prestige 14 Evo. That's not the case with the M1.

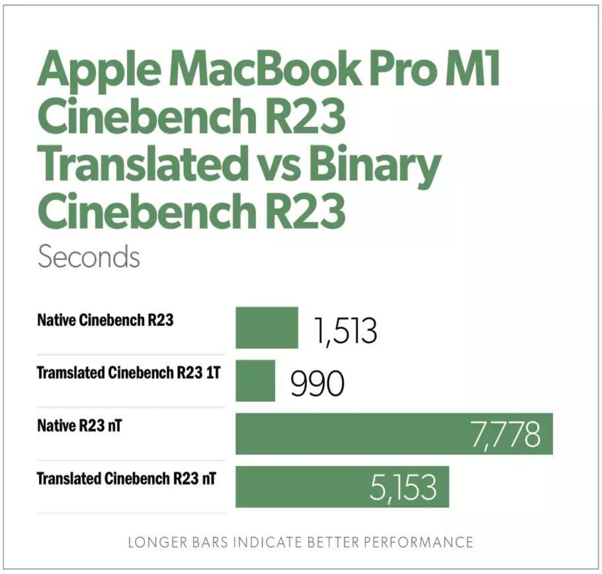
Keep in mind when you look at the chart above that the shorter bar indicates higher performance as we're looking at how long it takes to render the scene.

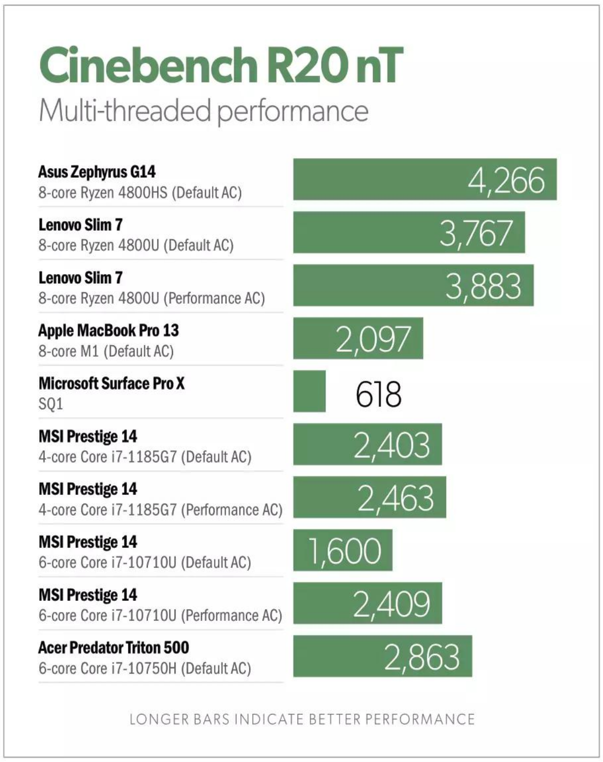
Since both versions render what appears to be exact same frame, we can see the rendering time for both multi-threaded and single-threaded performance is about 28 percent less going from the translated version to the native version of Cinebench on Apple's MacBook M1. That's really not bad, and in line with what others have seen the cost of the Rosetta 2 to be.

What's a little strange is there's another way to run Cinebench R23 that forces the M1 to run it translated: Order the universal binary to install the Intel version of it, rather than the M1-native version. *Macworld* again graciously agreed to run it this way and the result was significantly worse.

Here's the default 10-minute run of Cinebench R23 on the MacBook Pro M1 using the native-binary and the Intel-binary. We're looking at closer to a 50 percent hit from using the Rosetta 2 translator to make the x86-code run on the Arm-based M1 chip. That's not pretty.

The big takeaway? Software that gets converted to native code on the M1 should almost always pick up very large gains in performance. And for applications that never get converted to native code, you'll always be paying a very hefty performance tax.





That's bad, but you need to keep it in context. Overall, Rosetta 2 and the M1 is still largely a success for those who had performance concerns. And if you're wondering why people had concerns over performance, you can see that above, where we take Cinebench R20 (non-native on the MacBook Pro's M1) and dial in a score generated on Microsoft's Surface Pro X tablet.

The Surface Pro X tablet is unique among PCs because it's based on Qualcomm's custom SQ1 chip built for Microsoft, running on Arm architecture rather than traditional x86

MacBook Pro M1.

cores. This week Microsoft released its beta 64-bit support and let's just say it doesn't perform nearly as well as Rosetta 2 does on Apple's M1 chip. Our Surface Pro X versus MacBook M1 comparison (go.pcworld.com/sxm1) contains much deeper information, but Arm on Windows has never looked worse.

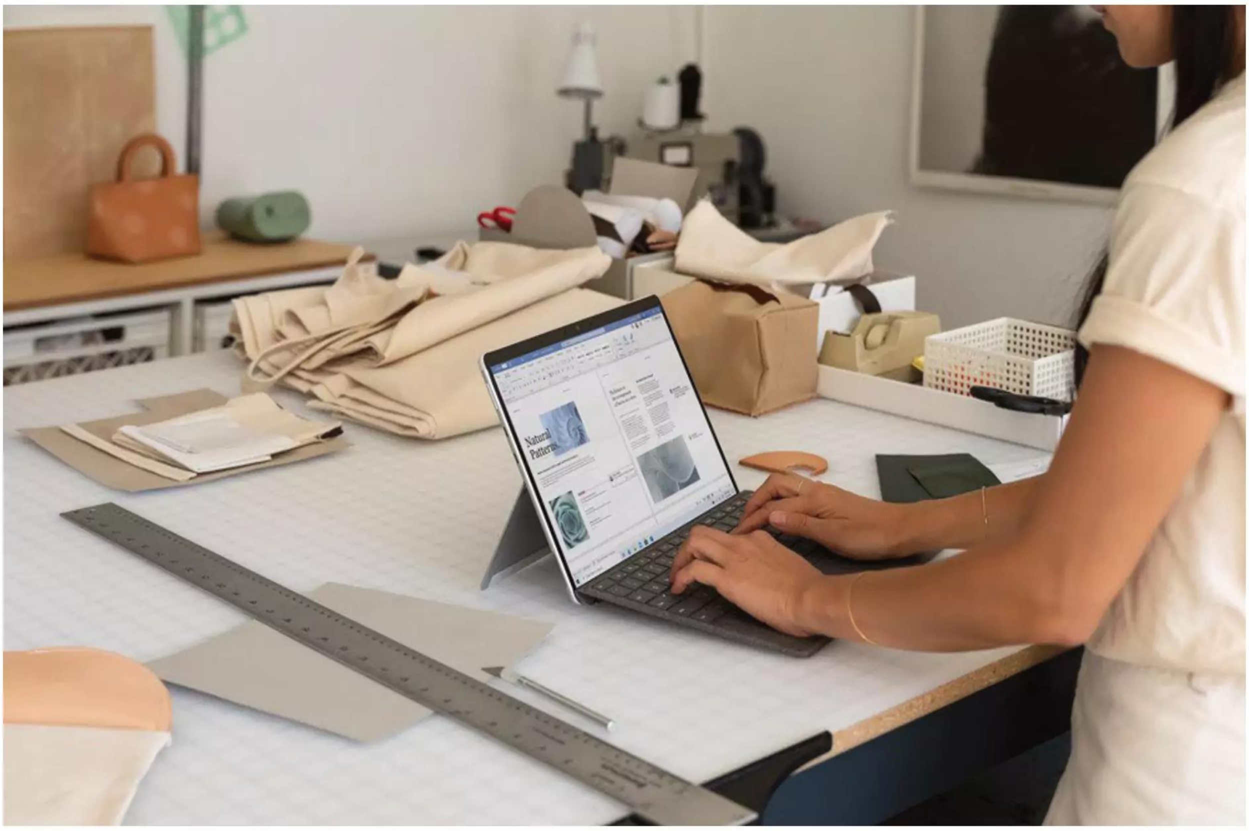
BOTTOM LINE

In today's technology circles, many people have retreated into their corners, with irrational fans choosing to always cheer for their team and give no quarter to competitors—even if the other team won. That shouldn't be any rational person's perspective because ultimately, these are just companies looking to take your money. It's also not classy.

With that said, we think Apple should be applauded for what it has pulled off with the new M1 chip. It offers truly amazing performance that looks like it can carry the Mac down the fork of the road away from the world of x86. You can arguably say Macs built on the new M1 will be worthy of the heritage of the Macintosh name, which hasn't been the case over the last few years. With the M1 and Apple's future iterations, heads can be held high again.

Yes, there will be faster chips from Apple. And we can tell you there will be faster chips from AMD, Intel, and Nvidia too. There might even be faster chips from Qualcomm.

That's ultimately all good for consumers. We benefit from competition among worthy products—and you can certainly say Apple's MacBook Pro M1 is a worthy product (go.pcworld.com/glrv).



Tested: How badly Windows on ARM compares to the new Mac M1s

Two years ago, Windows on ARM looked viable. Now, it needs a lifeline. **BY MARK HACHMAN**

After Apple released its impressive M1 Arm chip on its new Macs, and Microsoft followed with its long-awaited 64-bit X86 emulator, we had just one question: How does Windows on ARM compare to macOS on ARM? The answer: badly. Very, very badly.

Running Windows apps on ARM processors has a few wrinkles. For one, there are only two chips currently powering Windows on ARM machines: Qualcomm's own processors, such as the Snapdragon 8cx (go.pcworld.com/8cx1) and Snapdragon 8cx Gen 2 (go.pcworld.com/8cx2), as well as the derivative SQ1 and SQ2 processors Microsoft co-designed with Qualcomm. The latter two processors both appear in Microsoft's Surface Pro X tablet.

Until last week, WOA devices have only been able to run apps coded natively for the Snapdragon ARM architecture, or run 32-bit

IMAGE: MICROSOFT

Apple and its M1-powered MacBook Air have accomplished what Microsoft hasn't: delivering a viable new ARM ecosystem of hardware and software.

apps coded for X86 processors natively. Last week, after an awkward delay, Microsoft finally published its long-awaited 64-bit X86 emulator (go.pcworld.com/x86m), allowing Windows on ARM PCs to run 64-bit X86 apps via emulation. The vast majority of apps today are optimized for 64-bit processors and the larger amount of memory they can address. Because the apps are being emulated and not running natively, they will run more slowly than native code. Apple, too, has shipped Macs running on its own 64-bit ARM chip, the M1, and shipped a finalized 64-bit emulator alongside it.

Given the glowing reviews by our sister site, *Macworld*, we know how well the new MacBook Air (M1) (go.pcworld.com/m1ai) and other M1-based hardware performed. Now that Microsoft has shipped its own 64-bit emulator, we can more directly compare how well Windows on ARM compares to macOS on ARM.

HOW WE TESTED

Our testbed was Microsoft's Surface Pro X (go.pcworld.com/mspx), running on a first-generation SQ1 chip, a more powerful version of Qualcomm's Snapdragon 8cx. (We did not have an SQ2-powered Surface Pro X to test.) We downloaded and installed Windows Insider Build 21277 and the additional code, such as Adreno GPU drivers, to allow 64-bit X86 apps to run. (Microsoft warned that not every app would work, even with its emulator.) We used Apple's MacBook Air (M1) as a comparison.

We already had a good idea of how slow Microsoft's Surface Pro X is—that was evident from our original review (go.pcworld.com/hslw). But these benchmarks provide insight into just how slowly the Surface Pro X and its SQ1 chip run with the new 64-bit X86 instruction emulator layered on top. We hewed closely to the test suite from

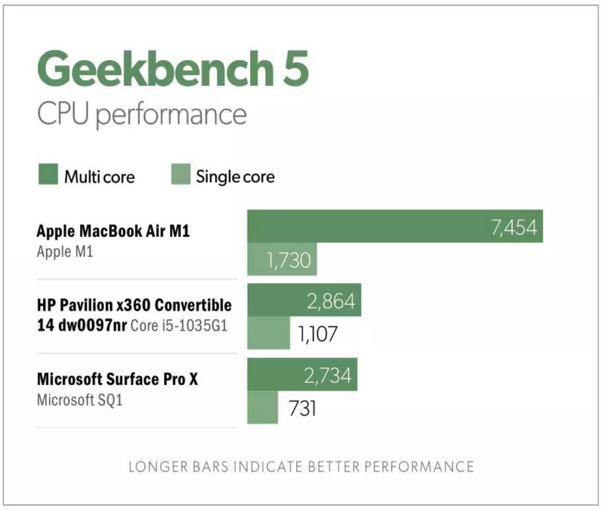
Macworld's MacBook Air review, including GeekBench 5, Cinebench R23, HandBrake, and a representative game, *Rise of the Tomb Raider*. We added a third Windows laptop for reference: the HP Pavilion x360 Convertible 14 (go.pcworld.com/cn14), a decidedly average $700 laptop with a fairly pedestrian Core i5-1035G1 inside.

To be fair, Microsoft's emulator is in preview, and Microsoft promises performance will improve over time. Also, we're comparing the first-gen SQ1 chip, which maxes out at 3GHz, and not the current SQ2—though the SQ2 offers a teensy upgrade to a 3.1GHz boost clock. We tried testing with the Windows performance slider set to maximum, and the results were unchanged. Windows on ARM lags so far behind the MacBook on M1 that it's hard to believe further improvements will bring it significantly closer.

Enough preamble—let's look at how soundly Apple's MacBook with the M1 chip trounces Windows on ARM's best.

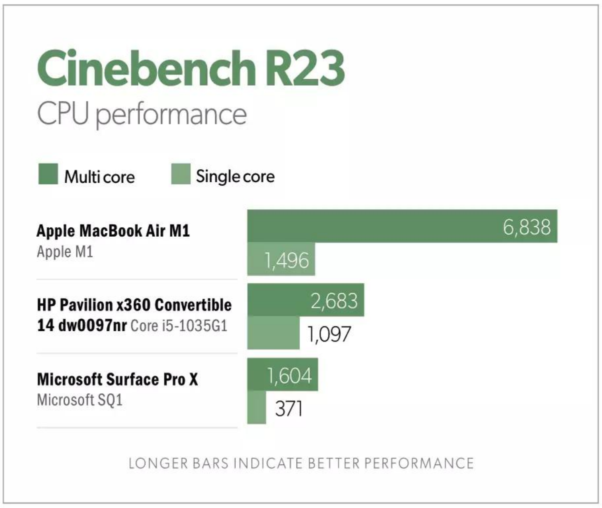
HOW MICROSOFT'S SQ1 COMPARES TO APPLE'S M1

Geekbench offers both a CPU-specific test, and a "compute" benchmark that ropes in the GPU. The current version of Geekbench 5 couldn't accommodate the SQ1 in the latter test, so we show only the CPU test in single-core and multi-core. We can see that the SQ1 pales in comparison to a Core chip and the Apple MacBook M1.

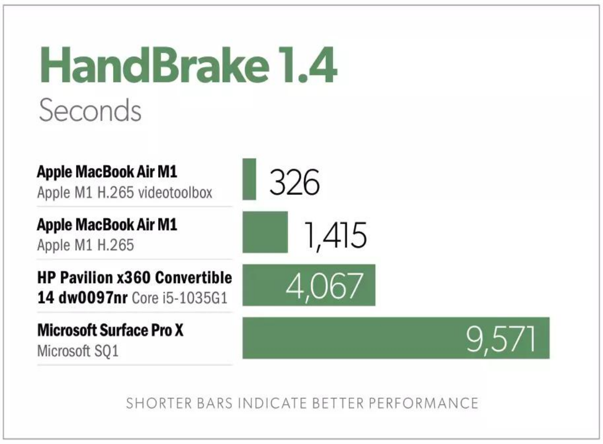


Although the Microsoft SQ1 chip inside the Surface Pro X can hang with the Core i5-1035G1 inside our budget HP Pavilion, there's no way it can compete with the Apple MacBook M1.

Maxon's Cinebench paints a rendered two-dimensional image. *Macworld* jumped to the most recent R23 benchmark, which uses a more complex image than the R15 version *PCWorld* has used. The new R23 release



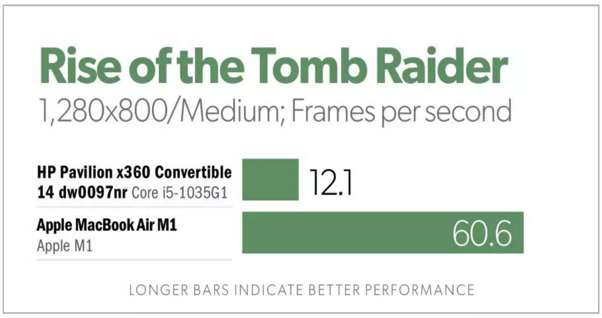
In pure CPU performance as measured by Cinebench, Apple's M1 holds more than a fourfold performance advantage over the Surface Pro X and Microsoft's SQ1.



Although we're using different versions of HandBrake in our comparison, the tool is not the difference here. The MacBook Air M1 is more than six times faster than the Surface Pro X in video transcoding.

supports Apple's silicon, with no specific optimizations for the SQ1 or Qualcomm's Snapdragon chips. Nevertheless, Windows on ARM running on the Surface Pro X isn't even in the same league as the Apple MacBook M1.

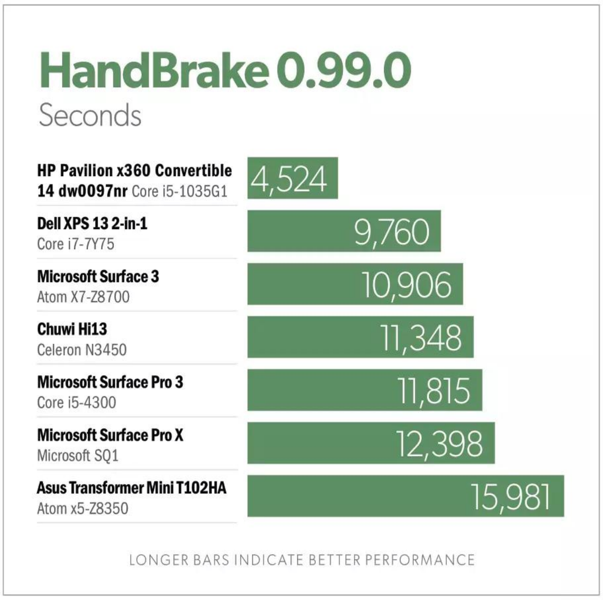
HandBrake is an open-source video transcoding tool, and a popular benchmark. Its latest version, version 1.4, is written specifically for macOS, to accommodate the new M1 processors. We used the last public version, 1.33, for our Windows test. But the version is not the real difference here. The SQ1 chugged along at about a frame per second, taking about two hours to transcode a 12-minute 4K video, *Tears of Steel*, into a 1080p H.265 format. Apple's MacBook M1 simply blows away the Surface Pro X.



We'd like to say that we were able to run *Rise of the Tomb Raider*, part of our test suite for gaming PCs, but the Surface Pro X simply wouldn't. Instead, we ran the HP Pavilion on the benchmark at 1280x800 resolution (Medium settings) to compare against the MacBook M1.

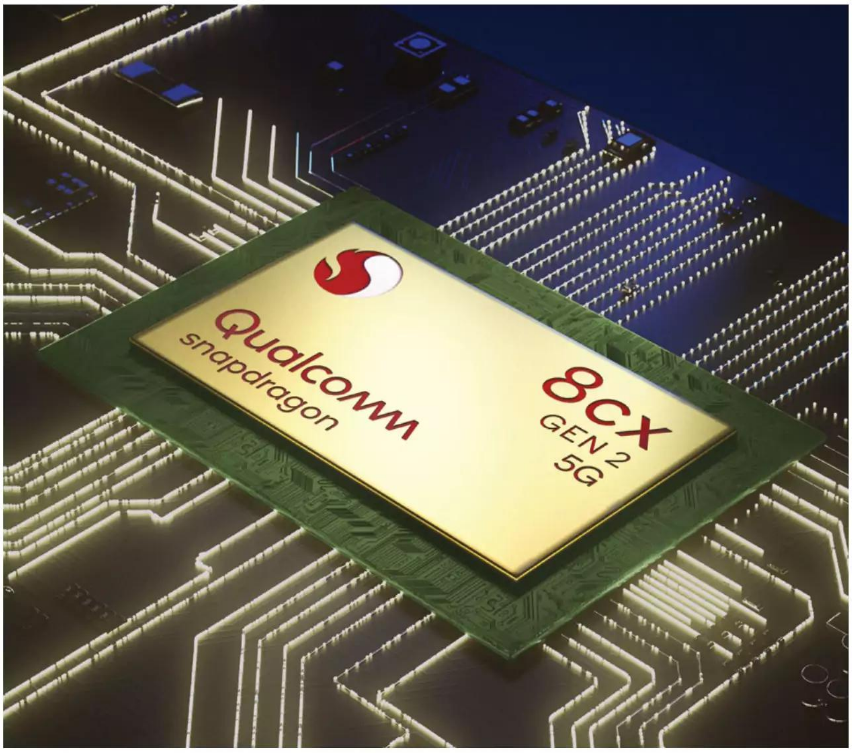
MICROSOFT'S SQ1 VERSUS OTHER WINDOWS LAPTOPS

We took the opportunity once again to see how the Surface Pro X and its SQ1 chip, with the beta X86 emulator, compares against a suite of Windows laptops. Here, too, we ran



Once again, the Surface Pro X finishes roughly four times slower than our 2020 budget laptop, the HP Pavilion x360 Convertible 14.

into compatibility issues. A 3DMark Sky Diver test that we usually use to test 3D performance wouldn't run on the Adreno GPU. PCMark 8 Creative failed to run, too—though it did when we originally reviewed the Surface Pro X. We weren't able to run Cinebench R15, a standard workload for our laptop testing. We were, at least, able to run an older version of HandBrake.



Qualcomm hasn't launched a significant Windows on ARM chip in about two years.

HandBrake exposes how weakly the SQ1 performs against modern Windows laptops running X86 processors from Intel and AMD. Even a budget laptop from three years ago, the Chuwi Hi13 (go.pcworld.com/chwi), topped the Surface Pro X.

BOTTOM LINE

Two years ago, the future of Windows on ARM looked bright. With what we hoped was a 64-bit emulator waiting in the wings, the Snapdragon's "good-enough" performance could hold its own, especially with the perks of all-day battery life and LTE connectivity. Today, Project Athena/Evo laptops from Intel's partners have caught up in all these area. Qualcomm hasn't launched a significant Windows on ARM chip in about two years, and during its recent Snapdragon Tech Summit the company had basically nothing to say about its future PC plans (go.pcworld.com/fpln).

Microsoft's 64-bit X86 emulator is still in beta, so we can't make definitive statements about its success. But it's hard to believe that further development will bridge the vast gulf of performance between Windows on ARM and Apple's M1-based Macs. In six months, Microsoft may be able to boast that its emulation performance has improved by a significant amount. But without the combined miracle of a much better CPU from Qualcomm or another Arm chipmaker and continued improvements from Microsoft, the future of Windows on ARM looks grim.

Lenovo IdeaPad Slim 7: Fast and affordable, with discrete graphics

Content creators will get a kick out of the productivity features. **BY BEN PATTERSON**

Packed with features sure to make productivity mavens happy, the Lenovo IdeaPad Slim 7 delivers both performance and value in a slim and trim shell, even if its battery life isn't quite what we'd hoped.

Powered by a Core i5 Ice Lake processor (go.pcworld.com/i5il) and armed with discrete GeForce MX350 graphics, this configuration of the IdeaPad Slim 7 ($880 from Lenovo; go.pcworld.com/880l) deftly handles crushing CPU loads and Adobe Premiere-level graphical chores. It also boasts such niceties as a Thunderbolt 3 port, facial and fingerprint biometrics, Dolby Atmos sound, and Wi-Fi 6 support.

IMAGE: BEN PATTERSON

The IdeaPad Slim 7's battery life fell a little short of our expectations, and the laptop's staid design, while pleasingly slim, won't wow anybody (which shouldn't surprise anyone familiar with Lenovo's IdeaPad line). Still, it offers a good feature set for this price range (or even cheaper, if you can grab Lenovo's "instant" discount).

CONFIGURATION

Lenovo offers five versions of the IdeaPad Slim 7, ranging from our unit (82A4000MUS) to a $1,130 (or $1,017 post-discount) version with a Core i7-1065G7 CPU, 16GB of RAM, a 512GB SSD, and an integrated Intel Iris Plus GPU. There are also IdeaPad Slim 7 models powered by AMD Ryzen 4000-series chips (here's our performance preview [go.pcworld.com/ls7p]), but Lenovo is currently out of stock. More units are in the pipeline, we're told.

Here are the detailed specifications on the system we reviewed:

CPU: Quad-core Intel Core i5-1035G1 (Ice Lake)

Memory: 8GB LPDDR3 3200MHz

Graphics: Discrete Nvidia GeForce MX350

Storage: 512GB SSD

Display: 14-inch FHD (1920x1080) IPS, 300 nits, non-touch

Webcam: 720p

Connectivity: One Thunderbolt 3 port, one USB SuperSpeed 5Gbps Type-C, two USB SuperSpeed 5Gbps Type-A, HDMI, combo audio jack, microSD slot

Networking: Wi-Fi 6, Bluetooth 5.0

Biometrics: IR facial recognition, fingerprint sensor

Battery capacity: 60.7 Watt-hour

Dimensions: 12.62 x 8.19 x 0.58 inches

Weight: 3.2 pounds (measured), 0.68-pound AC adapter

Just looking at the specs, this is a rock-solid configuration for the price, starting with the peppy Core i5 Ice Lake CPU, the roomy 512GB SSD, and the 8GB of low-power RAM (though 16GB would have been better). The discrete MX350 graphics card won't deliver silky gaming visuals, but it should do the trick for content creators.

You also get a reasonably bright 14-inch full-HD display. It's non-touch, unfortunately, although pricier SKUs do offer touchscreens. The Thunderbolt 3 port is great for connecting dual 4K displays and speedy external storage, and a pair of SuperSpeed USB-A ports handle legacy peripherals. More goodies include facial and fingerprint biometrics, plus Wi-Fi 6 (time to pull the trigger on that Wi-Fi 6 router [go.pcworld.com/wf6r] you've been pining for), while the beefy 60.7-Watt-hour battery promises plenty of battery life (as we'll see in our performance section).

DESIGN

True to its name, the Lenovo IdeaPad Slim 7's 0.58-inch profile is svelte, but the laptop's

As far as the Lenovo IdeaPad Slim 7's design goes, well ... it's what's inside that counts, right?

aluminum, slate-gray lid is completely featureless save for a small "Lenovo" logo on the side. In other words (and as with other laptops in Lenovo's IdeaPad line), don't expect the Slim 7 draw any envious looks while you're out and about. Still, we appreciate the lip along the top edge of the lid, which makes it easier to pry the laptop open with your fingertip.

Opening the lid reveals more of the same, with a slate-gray, spill-resistant keyboard and palmrest matched by a glass trackpad. The 14-inch display is surrounded by relatively thin side and top bezels, with a slightly chunkier bezel along the bottom. A long, flat hinge allows the lid to open all the way to a 180-degree angle, which could come in handy if you want to flip the display for a slideshow or PowerPoint presentation.

Weighing in at 3.2 pounds, the IdeaPad Slim 7 feels a tad heavy for its size. That said, a sub-three-pound laptop with the Slim 7's feature set would probably cost a few hundred dollars more.

DISPLAY

Rated at 300 nits of brightness, the Lenovo Slim 7's 14-inch full-HD display looked sharp and bright to my eyes. I generally kept the brightness setting down in the 70- to 80-percent range while testing the laptop indoors--cranking the brightness up to 100 percent made the screen uncomfortably bright. The display was also easy to see outside under an umbrella, although its glossy finish makes for tough reading in direct sunlight.

The Slim 7's IPS (in-plane switching) display boasts characteristically wide viewing angles. The screen dims only slightly when viewed from the sides or above. Even when looking at the display from close to a 90-degree angle, I had little problem reading the text in an on-screen Word document.

KEYBOARD, TRACKPAD, SPEAKERS, AND EXTRAS

The IdeaPad Slim 7's keyboard feels great to type on. The keys themselves offer plenty of travel, and keystrokes feel snappy and springy, perfect for avid typists. Even better, the keyboard is quiet enough that you won't disturb those in close proximity. You also get hotkeys for mic mute, airplane mode, Windows 10 settings Windows lock, Task View, and the Calculator app. There aren't any media playback hotkeys.

The Slim 7's glass-covered touchpad felt smooth and responsive. Crucially, it did a fine job of rejecting false inputs, both during the regular course of my typing and also when I deliberately smushed my palms into the bottom corners of the trackpad. I noticed perhaps a couple instances of a herky-jerky cursor during several weeks of testing, but otherwise, it was smooth sailing.

The IdeaPad's fingerprint sensor is embedded into the power button that sits on the right side of the laptop, up near the hinge. The fingerprint reader was awfully finicky during my testing, perhaps because of the sensor's slightly awkward positioning on the side of the laptop. In any case, I frequently had to rescan my fingertip before successfully unlocking my Windows profile. Luckily, I had much better luck with the IR camera, which worked pretty much flawlessly and made unlocking the Slim 7 a breeze. Once I got started with facial recognition on the laptop, I never looked back.

Equipped with a pair of upfiring speakers that have been optimized for Dolby Atmos, the Lenovo IdeaPad Slim 7 delivers impressive sound for a laptop, although (here comes our usual disclaimer) you'll get much better audio from an external speaker or a pair of headphones. Tuning up "Live and Let Die" by Paul McCartney and Wings, the Slim 7's speakers teased out plenty of detail while not ignoring the mid-range. There was even some

ideapad Slim 7
Premium Entertainment
Powerful Battery
Smart IR Cam & More
DOLBY ATMOS

The Lenovo IdeaPad Slim 7 boasts a comfy, snappy keyboard, while its touchpad does a nice job or rejecting false inputs.

decent bass—well, decent by laptop standards, anyway. The Atmos-enabled speakers also managed to do a solid job of serving up a virtualized 3D soundstage (although again, we're grading on a curve),. You can fine-tune the sound using the included Dolby Atmos desktop app.

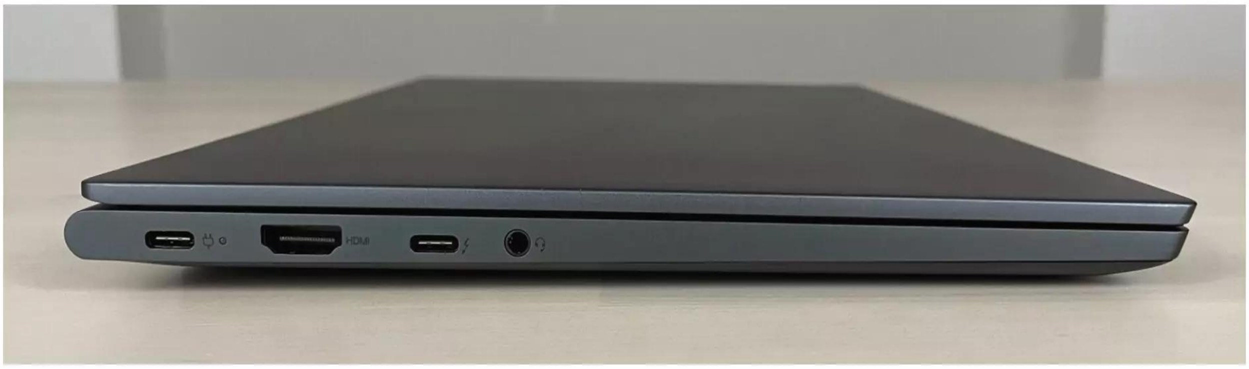
The IdeaPad Slim 7's 720p webcam captures blotchy, washed-out video that's adequate for Zoom and Skype video calls, but just barely. If you're planning on presenting to a large group or if you're going on virtual job interviews, you'd be better off with a dedicated webcam (go.pcworld.com/dwbc).

PORTS

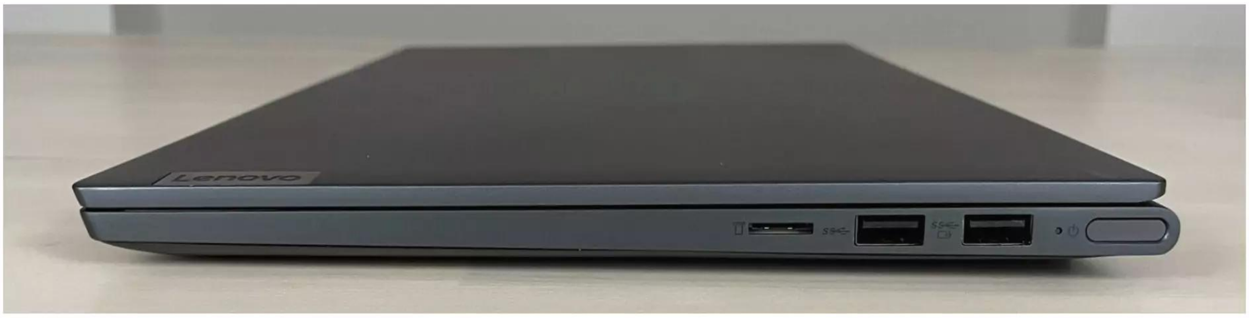
The Lenovo IdeaPad Slim 7 has just about every base covered when it comes to ports, including (on the left side) one that we rarely see in this price range: Thunderbolt 3, handy for connecting a pair of 4K monitors or hooking up a fully loaded laptop hub. Also on the left side is a full HDMI port, a combo audio jack, and a USB-C Power Delivery port.

On the right, you'll find a pair of USB SuperSpeed 5Gbps Type-A ports (we would have preferred SuperSpeed 10Gbps, but let's not get greedy) and a microSD card reader.

All that's missing is ethernet, although that's a lot to ask given the svelte design.



The left side of the Lenovo IdeaPad 7 features a Thunderbolt 3 port, a full HDMI port, a combo audio jack, and a USB-C power port.



A pair of USB SuperSpeed 5Gbps Type-A ports sit on the right side, along with a microSD slot. A fingerprint reader is embedded in the power button.

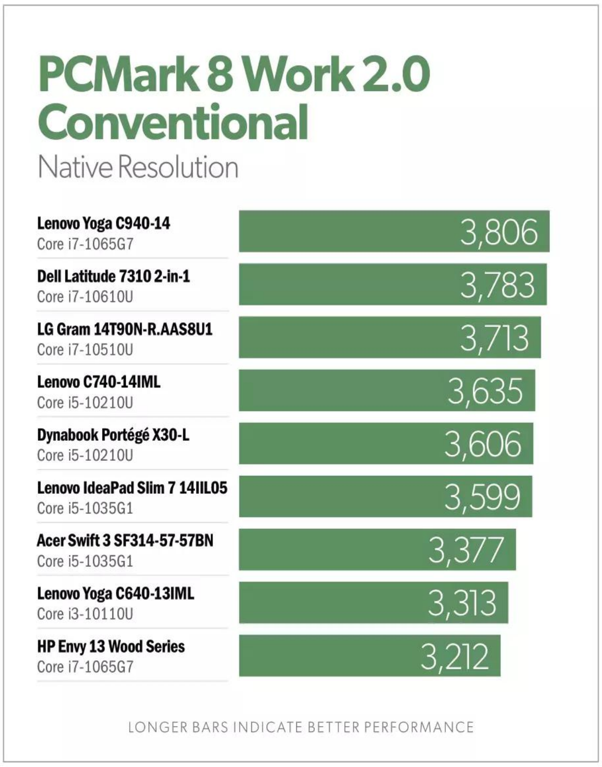
GENERAL PERFORMANCE

With its quad-core, Core i5 Ice Lake CPU and discrete graphics, we were expecting plenty of productivity power from the Lenovo IdeaPad Slim 7, and that's just what we got. The Slim 7 handles Office and daily PC duties with ease, it excels at shouldering multi-core CPU loads over lengthy periods, and it packs enough graphical punch to please content creators. That said, the IdeaPad Slim 7 falls more in the middle of the pack when it comes to delivering quick bursts of power, and we've seen better battery life.

PCMARK 8 WORK CONVENTIONAL

Our first benchmark measures how well a given laptop performs during such everyday computing chores as web surfing, composing Word documents, tinkering with spreadsheets, and video chat. Because most of the tasks simulated by PCMark 8 require only a single computing core, laptops with fewer CPU cores remain on an even playing field with those that have more. A PCMark 8 score of 2,000 or higher generally means you'll see smooth Office performance.

So don't fret when you see the Lenovo IdeaPad Slim 7 sitting in the bottom half of our performance chart. Every laptop in the comparison pool of similar models breezed through the PCMark 8 benchmark with a score north of 3,000—easy peasy.

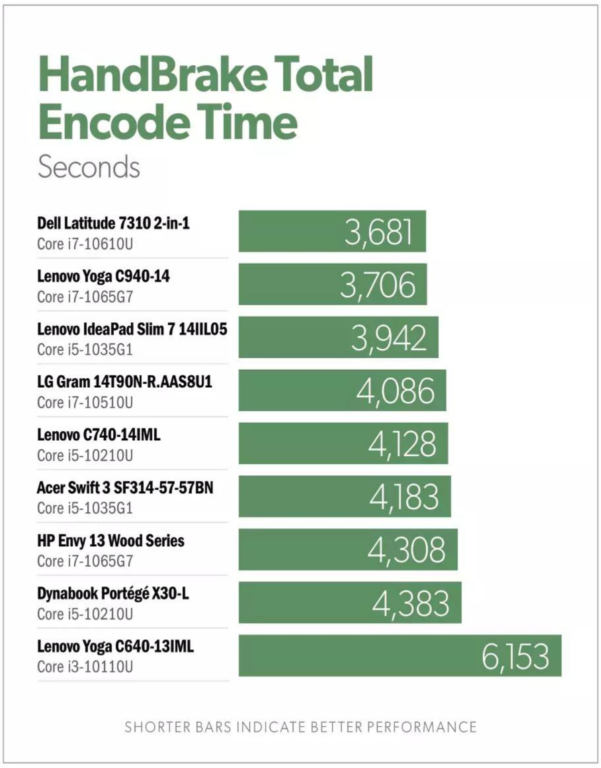


The Lenovo IdeaPad Slim 7 may have landed in the bottom half of our PCMark 8 chart, but in general, all the laptops in our roundup aced the benchmark.

HANDBRAKE

Our next benchmark involves using the free HandBrake utility to encode a 30GB .MOV video file into a format suitable for Android tablets. This lengthy, multi-core task is guaranteed to spin up cooling fans as CPU temperatures begin to soar. Given that it takes about an hour or so to complete the test, our HandBrake benchmark does a good job of showing us how a laptop handles heat buildup over time. In this case, laptops with the most cores generally get the best scores.

This time, the IdeaPad Slim 7 snags a solid third place (shorter bars are better for

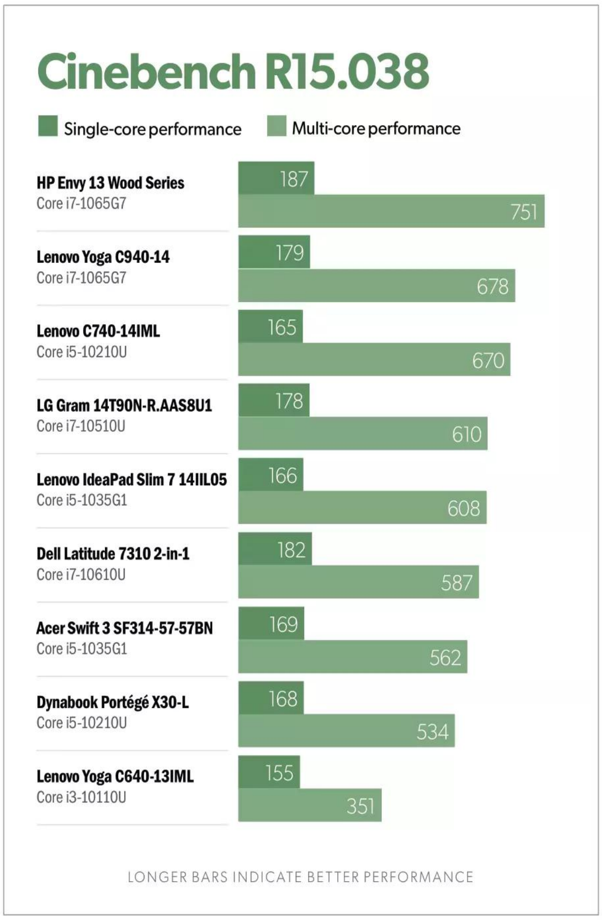


The Lenovo IdeaPad Slim 7 snags an impressive third place in our HandBrake benchmark, behind only a couple of more powerful Core i7 laptops.

HandBrake), behind a pair of other Ice Lake laptops with more powerful Core i7 CPUs, and notably ahead of another laptop (the Acer Swift 3) with the same Core i5 processor as the Slim 7. For a slim-and-trim laptop in the IdeaPad's price range, any HandBrake score south of 4,000 is exceptional. The Lenovo IdeaPad Slim 7 manages to sneak just beneath that mark, which is no small feat.

CINEBENCH

More of a sprint to HandBrake's marathon, Cinebench puts a laptop through its paces as it renders a 3D image in real time. Unlike the lengthy HandBrake benchmark, the Cinebench test is generally over in a matter of minutes, which means we expect laptops with the fastest boost clocks to get the upper hand.



The Lenovo IdeaPad Slim 7 is a little slower out of the gates than some of the other laptops here.

The Lenovo IdeaPad Slim 7's Cinebench performance is more so-so than it was for HandBrake, although to be fair, it's essentially neck-and-neck with the fourth-place LG Gram and its Core i7 Comet Lake CPU. If anything, it's the Core i5 Comet Lake-powered Lenovo Yoga C740 that's the surprise, nestled in the top three with those two Core i7 Ice Lake systems. But while the IdeaPad Slim 7 is a tad slower out of the gate than the Yoga C740, it's still well ahead of the Acer Swift 3 and its identical Core i5 Ice Lake chip.

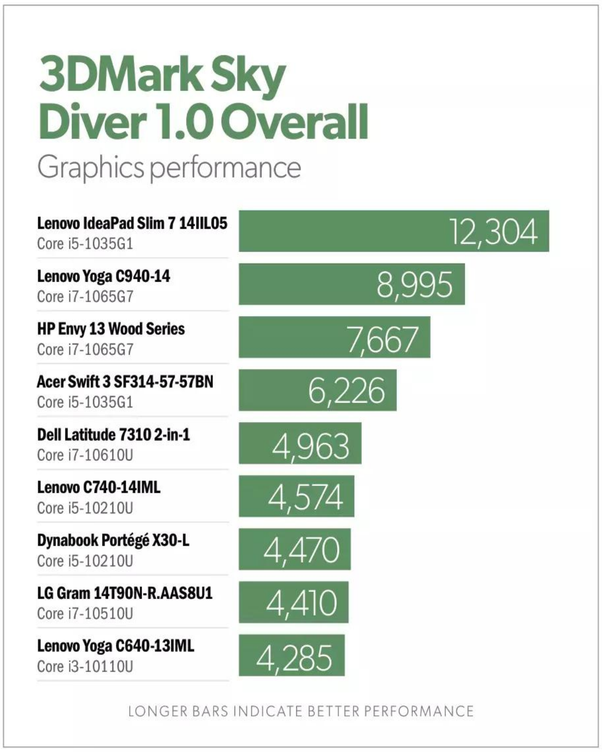
We are a tad concerned by the Slim 7's single-threaded Cinebench performance, which is third-to-last in our chart, although the laptop's solid PCMark 8 score gives us some comfort in terms of its single-core efficiency.

3DMARK SKY DIVER

The Lenovo IdeaPad Slim 7 comes equipped with a discrete Nvidia GeForce MX350 graphics card, an entry-level GPU that won't set your hair on fire in terms of gaming but should grease the wheels for Adobe Premiere and other content creation tools. We expected the Slim 7 to top the charts for our 3DMark Sky Diver benchmark, given that all the other laptops in our comparison only have integrated graphics.

And there you have it. The two Core i7 Ice Lake systems make a somewhat better showing than the rest, due to their turbocharged Iris Plus graphics cores, but they still can't hold a candle to the Slim 7's discrete graphics.

Just to put things in perspective, we also ran a couple of quick gameplay benchmarks, lest anyone were to think that the IdeaPad Slim 7 is a full-on gaming machine. As expected, the Slim managed only sub-30-fps visuals for *Middle-earth: Shadow of Mordor* and *Rise of the Tomb Raider* using their maxed-out graphics presets. To wring 60 fps or better from those two aging AAA games, you'll either have to dial the graphics way back or upgrade to a gaming laptop with, say, a GeForce GTX 1650 GPU or better.

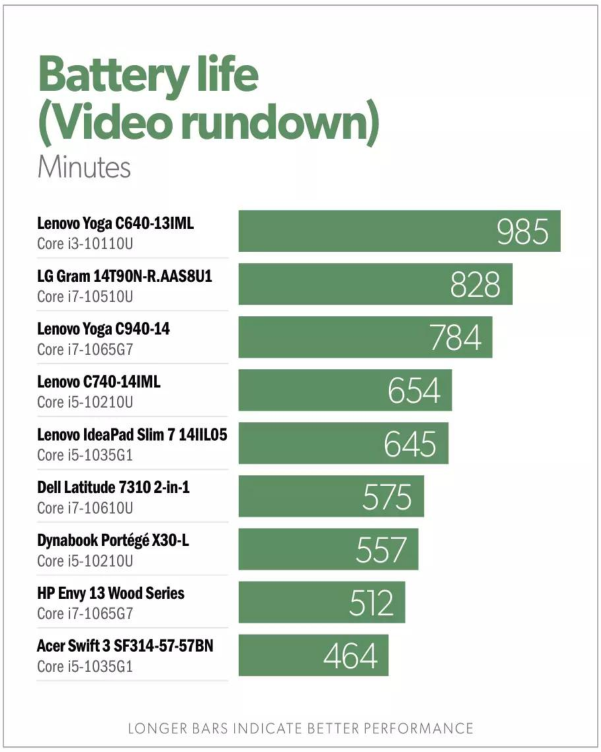


With its discrete GeForce MX350 graphics card, the Lenovo IdeaPad Slim 7 easily beats the other laptops in our chart with integrated graphics.

BATTERY LIFE

We test battery life on a laptop by looping a 4K video using the stock Windows Movies and TV app. We set screen brightness set to approximately 250 nits and volume to 50 percent, with headphones plugged in.

The Lenovo IdeaPad Slim 7's result here is decidedly meh. While the laptop's nearly 10.5-hour performance sounds pretty good at first blush (remember, of course, that the



The Lenovo IdeaPad Slim 7's battery life fell a bit short given its 60.7 watt-hour battery.

battery will drain much faster during CPU-intensive activities), we were expecting more given the Slim 7's sizable 60.7 watt-hour battery. The Lenovo Yoga C740, for example, pretty much matches the Slim 7's performance with a only a 50 watt-hour battery, while our chart-topping Lenovo Yoga C640 blows the Slim away with a 60.3Whr battery that's similar to the Slim's.

So, what's the deal here? First, let's consider the fact that the Slim 7's quad-core Core i5 Ice Lake CPU drains more power than the Yoga C640's dual-core Comet Lake chip, which gives the less powerful C640 a big advantage in terms of battery life. Then there's the Slim 7's discrete graphics core, which draws more power compared to the integrated graphics used by the other laptops in our chart. Finally, the Slim 7's impressive CPU performance—especially during our HandBrake benchmark—may be exacting a toll in the battery life department. (We ran our battery drain tests using the Slim 7's default "Balanced" power plan.)

BOTTOM LINE

We wish the Lenovo IdeaPad Slim 7 had more staying power in terms of battery life, and we wouldn't have minded faster burst performance, along with a touchscreen. Still, with its Core i5 Ice Lake CPU, discrete MX350 graphics, fingerprint and facial biometrics, Thunderbolt 3 port, and Atmos sound, the IdeaPad Slim 7 delivers an impressive arsenal of productivity tools for the price, as long as you can live without all-day battery life.

Lenovo IdeaPad Slim 7 14IIL05 82A4000MUS

★★★★☆

PROS

- Facial and fingerprint biometrics.
- Dolby Atmos sound.
- Thunderbolt 3 port.
- Discrete graphics.

CONS

- Middling battery life.
- Pedestrian design.

BOTTOM LINE

The Lenovo IdeaPad Slim 7 delivers both performance and value in a slim and trim shell, even if its battery life isn't quite what we'd hoped.

$791

GEFORCE RTX

Tested: How Nvidia Reflex can make you a better esports gamer

Lower latency, faster kills. Here's everything you need to know about Nvidia Reflex, and whether more powerful GPUs and faster monitors are worth the money. **BY BRAD CHACOS**

"Frames win games," Nvidia likes to say, but there's more to esports domination than raw frame rates. How those frames get delivered matters too. Latency—the time it takes for an on-screen action to happen after you press a button—reigns supreme in the blink-and-you're-dead competitive esports scene. If your game looks beautiful but feels sluggish, you'll find yourself outgunned by rivals playing with crummy visual settings to increase responsiveness.

Enter Nvidia Reflex, introduced alongside the GeForce RTX 3080 (go.pcworld.com/r308) and RTX 3090 (go.pcworld.com/r309). If you've heard of it before, you probably associate it with low-latency features being added to games like *Call of Duty: Warzone*,

IMAGE: MICROSOFT

Valorant, and *Fortnite*. But Reflex is actually Nvidia's overarching brand name for a wide range of new latency-obsessed tools. Yes, the Low Latency Mode being added to games is part of it, but on Tuesday, Nvidia and its partners are also rolling out blisteringly fast 360Hz G-Sync Esports monitors with Reflex Latency Analyzer built in. If you've invested in compatible accessories, Reflex Latency Analyzer keeps tabs on the entire pipeline from the millisecond you click your mouse to the millisecond the game renders your gun shooting, helping you identify which parts of your system are acting as a bottleneck.

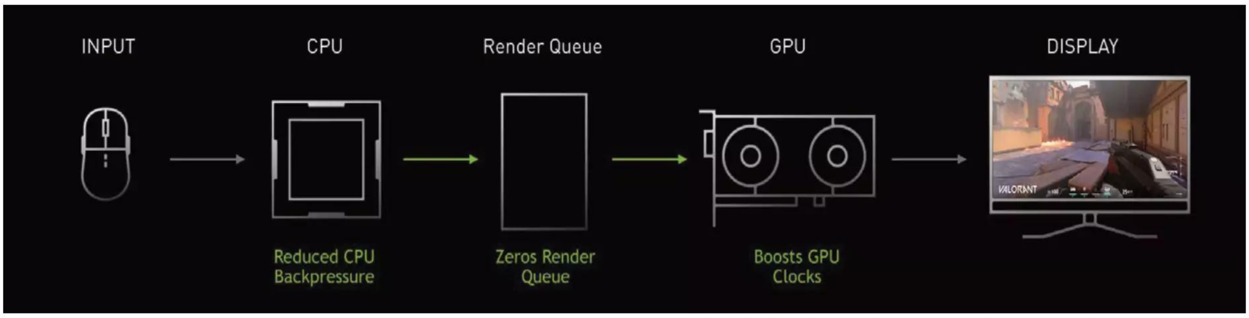
Nvidia's Reflex Latency Analyzer and the Reflex Low Latency Mode being introduced to leading esports games are two very different technologies, with two very different use cases, and perhaps two slightly different audiences. But they're both focused on the same underlying goal: making your games more responsive. You don't need one to use the other. And better yet, Reflex Latency Analyzer's powers let us evaluate the effectiveness of both, as well as measure how much faster your reactions would be if you invested in a pricier graphics card (go.pcworld.com/bggc) or a high refresh rate monitor.

Studies have shown that lower latency can improve your shot accuracy and kill-to-death ratios in competitive esports. Today, we're going to quantify responsiveness across a wide range of scenarios. Buckle up.

NVIDIA REFLEX LOW LATENCY MODE

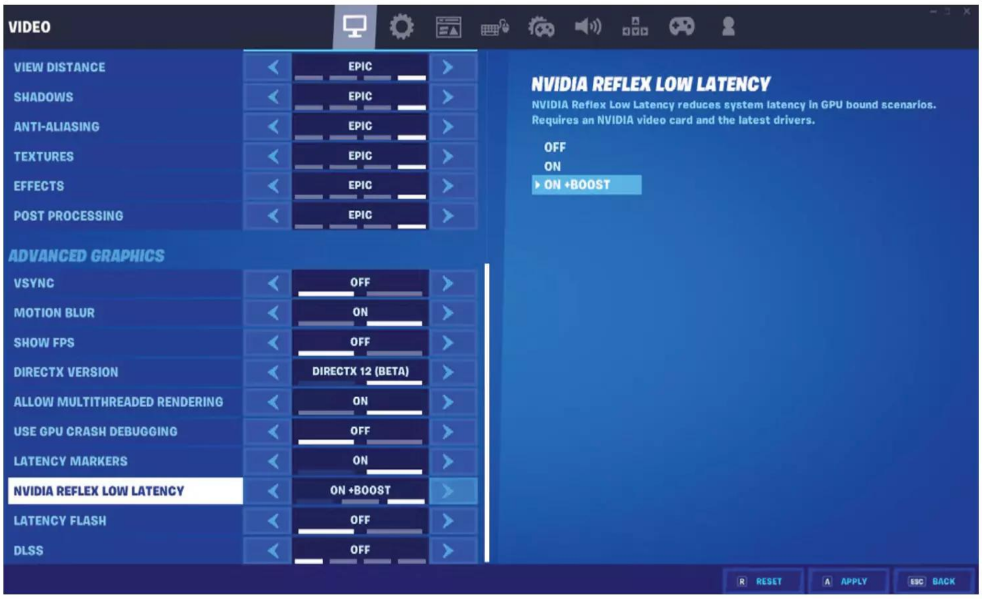
First, let's dig into the Nvidia Reflex Low Latency Mode you may already be seeing in the games you play. (For brevity, we'll call the software SDK "Nvidia Reflex" from here on out.) If you're just interested in raw benchmark results for a wide variety of scenarios, consider jumping straight to our benchmarking section instead (see page 84).

Nvidia Reflex is an optional set of APIs that developers can choose to implement in their game to reduce latency. It works particularly well in heavily GPU-bound scenarios—if you're playing an esports game on a higher-resolution monitor, or crank up all the eye candy, you'll see the most significant



How Nvidia Reflex improves latency in games.

responsiveness improvements, as you'll see in our benchmarks section.



VIEW DISTANCE	EPIC
SHADOWS	EPIC
ANTI-ALIASING	EPIC
TEXTURES	EPIC
EFFECTS	EPIC
POST PROCESSING	EPIC
ADVANCED GRAPHICS	
VSYNC	OFF
MOTION BLUR	ON
SHOW FPS	OFF
DIRECTX VERSION	DIRECTX 12 (BETA)
ALLOW MULTITHREADED RENDERING	ON
USE GPU CRASH DEBUGGING	OFF
LATENCY MARKERS	ON
NVIDIA REFLEX LOW LATENCY	ON +BOOST
LATENCY FLASH	OFF
DLSS	OFF

NVIDIA REFLEX LOW LATENCY
NVIDIA Reflex Low Latency reduces system latency in GPU bound scenarios. Requires an NVIDIA video card and the latest drivers.
OFF
ON
ON +BOOST

You need to activate the various Nvidia Reflex features in the visual options of games that support it, like *Fortnite*.

Technically, the Nvidia Reflex SDK works by zeroing out the render queue, allowing the game engine to tell the CPU to submit render work to the GPU just-in-time. That keeps your game from feeling sluggish. Because the CPU isn't under stress to supply a render queue, it can keep an eye out for mouse clicks until the last possible second, too.

We witnessed Reflex's increased click responsiveness when playing Valorant at 60Hz on a GeForce GTX 1660 with visual settings cranked. With Reflex active, our mouse delivered a blistering 0.5-millisecond response time across 100 clicks, comprised of mostly 0.4ms and 0.5ms clicks. With Reflex disabled, it averaged 0.6ms, with mostly 0.6ms and 0.7ms clicks. That's the most noticeable example, but across the board, we witnessed *slightly* better mouse latency with Reflex on. This particular benefit might be a bit hidden with the mouse we used for testing, though, as the Asus ROG Chakram Core (go.pcworld.com/chak) is *ludicrously* fast. Most mice take several milliseconds to register a click, but this one averages 0.5ms. Hot damn.

Nvidia supplements Reflex with an optional "Boost" feature that you can choose to enable. Boost, appropriately, keeps your GPU boost clocks higher so that frames hit your display faster. That may help Reflex provide a benefit even if you're already playing with low visual settings. In games, the Nvidia Reflex menu setting has three options: Off, On, and On + Boost. Because activating Boost doesn't have any drawbacks aside from a higher power draw, there's no reason to leave it disabled if you're using Reflex.

Nvidia Reflex only just rolled out, but we're already seeing games add it in. You can use Nvidia Reflex in Fortnite, Valorant, Apex

Legends, *Call of Duty: Warzone*, *Call of Duty: Modern Warfare*, *Call of Duty: Black Ops Cold War*, *Destiny 2*, *CRSED*, *Mordhau*, *Enlisted*, and *Warface*. Better yet, the feature works with GeForce graphics cards going all the way back to the GTX 900-series. You don't need a pricey RTX 30-series GPU to use it.

360HZ G-SYNC ESPORTS MONITORS WITH REFLEX LATENCY ANALYZER

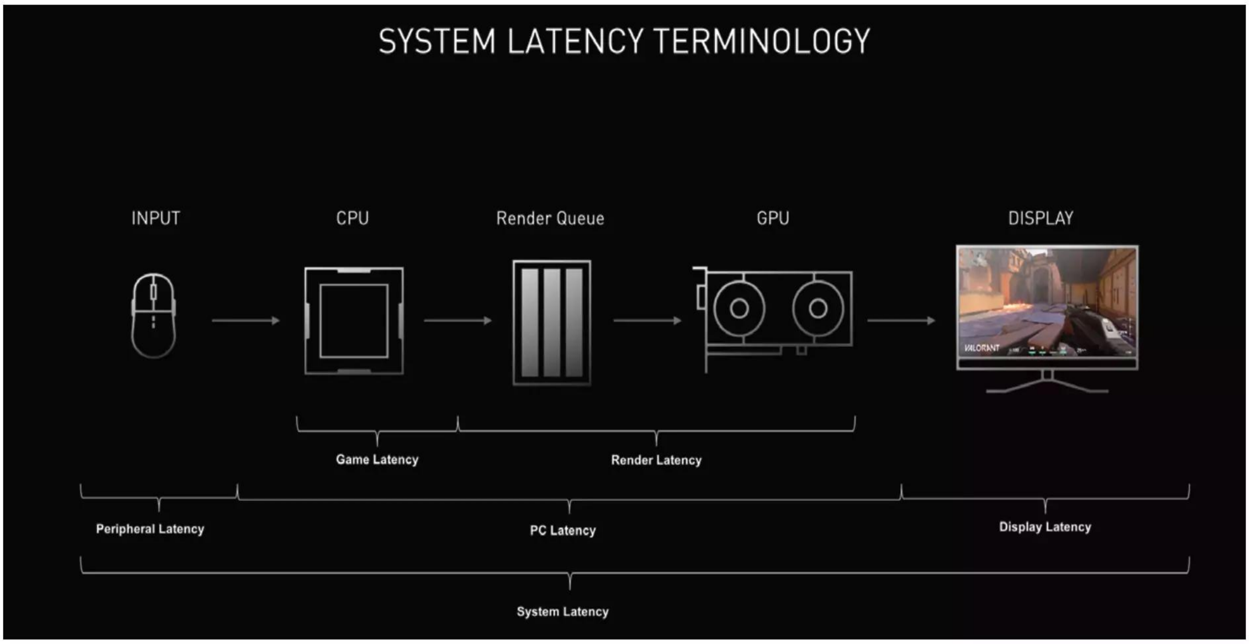
The Nvidia Reflex Low Latency Mode feature helps the majority of gamers out there—people who want their games to both look good and feel good. The other half of Nvidia's Reflex suite focuses on esports obsessives: people who play their games on low visual settings to eke out every drop of responsiveness, and who don't mind spending money to optimize their setup.

The Reflex Latency Analyzer comes integrated in four 360Hz G-Sync Esports monitors being unveiled Tuesday. These monitors are built around a new G-Sync processor that includes a USB pass-through port that was itself carefully tuned to avoid adding latency. Nvidia also worked with peripheral makers to create Reflex-compatible mice that send packets with exact click-timing information.

When you plug a Reflex-compatible mouse into the designated USB port on the rear of your display, and configure an on-screen box to identify your muzzle flash, Reflex Latency Analyzer can measure mouse latency, PC and display latency, and an overall system latency.

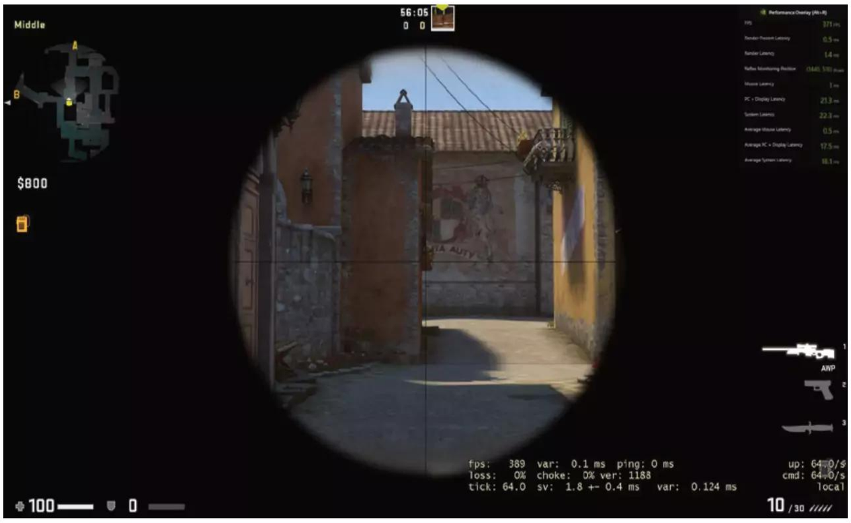
That's *very* helpful info for latency optimization while you're tinkering with game settings or hardware upgrades. Previously, you needed a 1000fps camera or specialized testing equipment to measure overall system latency. With Reflex Latency Analyzer, it's displayed in real time via a new on-screen display in GeForce Experience.

The Asus ROG Swift PG259QNR we used for testing.


SYSTEM LATENCY TERMINOLOGY
INPUT
CPU
Render Queue
GPU
DISPLAY
VALORANT
Game Latency
Render Latency
Peripheral Latency
PC Latency
Display Latency
System Latency

The Reflex Latency Analyzer found in 360Hz G-Sync Esports displays lets you measure all this.

The RLA overlay displays not one, not two, but *ten* different metrics. It's topped by FPS and render latency stats, but we're most interested in the items further down: Mouse Latency, PC + Display Latency, and System Latency. Mouse Latency speaks for itself and is tied to your Reflex mouse's left click. PC + Display Latency is "Measured from the moment the mouse click is received by the OS to the end of display latency," per Nvidia. This measurement also displayed by your monitor's on-screen display. System Latency combines the other two metrics to measure full end-to-end responsiveness.


Middle
56:05
0 0
$800
100
0
AWP
10 / 30

```
fps:    389  var:  0.1 ms  ping: 0 ms
loss:    0%  choke:  0% ver: 1188
tick: 64.0  sv:  1.8 +- 0.4 ms   var:  0.124 ms
```

```
up: 64.0/s
cmd: 64.0/s
local
```

Nvidia's Reflex Latency Analyzer overlay in the upper-right corner of Counter-Strike: Global Offensive.

In all three items, the "Average" measurement displays the average of the last 20 clicks and is more useful for analysis than the pure frame-to-frame numbers.

Reflex Latency Analyzer is kicking off with four Reflex-compatible mice: The Asus ROG

NVIDIA REFLEX SUPPORTED BY TOP ESPORTS DISPLAYS AND MICE

ASUS ROG Swift 360Hz PG259QNR

Acer Predator X25

MSI Oculux NXG253R

Alienware 25 Gaming Monitor | AW2521H

ROG Chakram Core

Logitech G Pro Wireless

Razer DeathAdder v2 Pro

SteelSeries Rival 3

The monitors and mice currently compatible with Nvidia's Reflex Latency Analyzer.

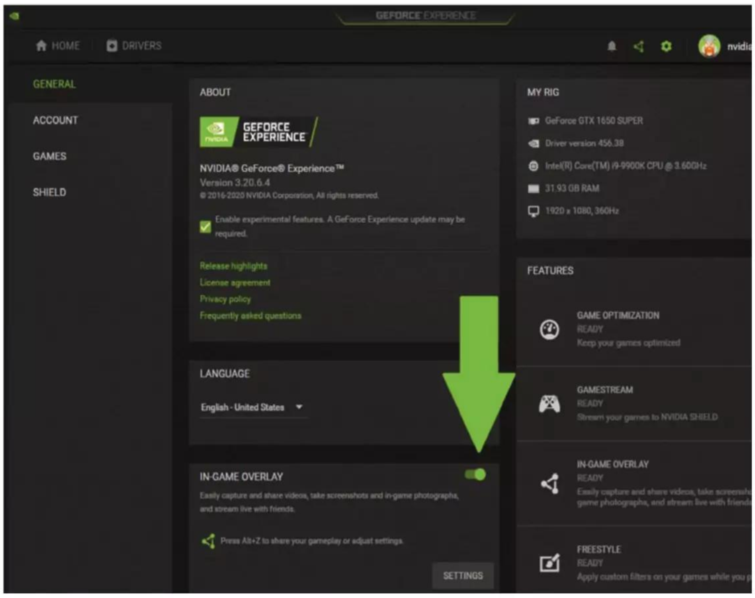
Chakram Core (go.pcworld.com/chak) we used for testing, the Logitech G Pro Wireless, the Razer DeathAdder v2 Pro, and the SteelSeries Rival 3. You may need to download new firmware to enable Reflex support. If you don't have a Reflex-compatible mouse, Nvidia's setup can't measure your mouse latency, which prevents the full system latency from being measured as well. That said, if you have one of the most commonly used esports mice, RLA still works. From Nvidia's reviewer's guide:

"For mice that have not gone through our validation process to become Reflex Latency Analyzer Compatible, there is a mouse database that stores the average latencies of known mice as well, making full System Latency analysis still possible. We will be adding new mice to the database as well as continuing to validate new per-click Reflex Latency Analyzer Compatible mice."

Even if your mouse isn't supported whatsoever, you can still track PC + Display Latency with Nvidia's tools. That can be very helpful while you're optimizing your game settings or hardware setup.

Four monitors are kickstarting the RLA ecosystem: the Asus ROG Swift PG259QNR, the Acer Predator X25, the MSI Oculux NXG253R, and the Alienware AW2521H. These are all high-end 1080p, 360Hz G-Sync monitors, rocking the same advanced G-Sync processor and even the same AU Optronics panel. While bleeding-edge refresh rates typically kick off with faster, but less vibrant (TN) panels, these debut 360Hz monitors feature dual-driver IPS panels that maintain face-melting speeds without sacrificing color. Hallelujah. We're testing the Asus ROG Swift PG259QNR (go.pcworld.com/p259), and the almost tactile smoothness of a 360Hz refresh rate can't be overstated. From games to mousing around the desktop, everything runs like butter, and Asus's hardware and software polish is top-notch.

Because these displays all use the same underlying hardware, Nvidia was able to create a new G-Sync Esports feature that provides an identical experience across monitors. Activated via your display's options menu, G-Sync Esports puts the display into high-power mode, disables variable backlighting, activates Nvidia's Dark Boost technology, and increases the gamma rating to show shadowy areas more clearly. That can impact contrast ratio aesthetics, but competitive gamers will appreciate the tactical advantage. Nvidia says it can help provide a uniform experience in high-end competitions.



NVIDIA® GeForce® Experience™
Version 3.20.6.4
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☑ Enable experimental features. A GeForce Experience update may be required.

Release highlights
License agreement
Privacy policy
Frequently asked questions

English - United States

IN-GAME OVERLAY
Easily capture and share videos, take screenshots and in-game photographs, and stream live with friends.
Press Alt+Z to share your gameplay or adjust settings.

GeForce GTX 1650 SUPER
Driver version 456.38
Intel(R) Core(TM) i9-9900K CPU @ 3.60GHz
31.93 GB RAM
1920 x 1080, 360Hz

GAME OPTIMIZATION
READY
Keep your games optimized

GAMESTREAM
READY
Stream your games to NVIDIA SHIELD

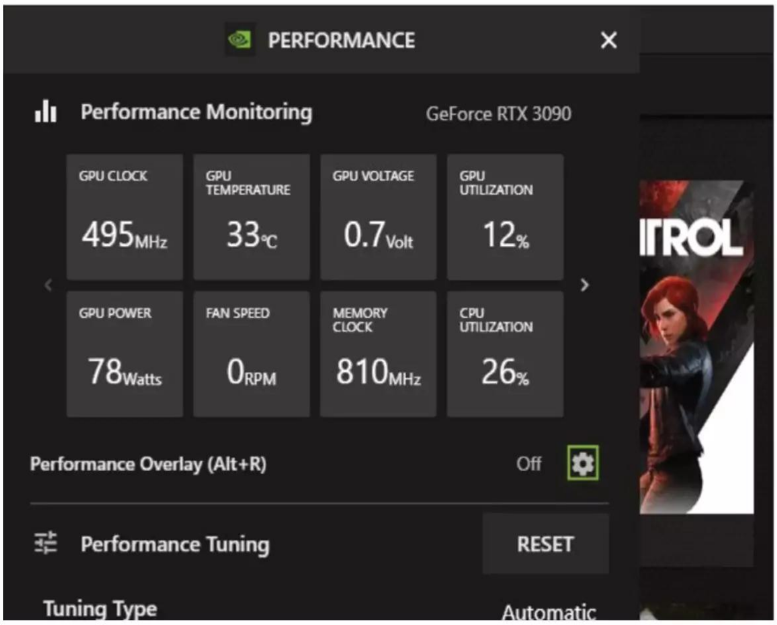
IN-GAME OVERLAY
READY
Easily capture and share videos, take screensh
game photographs, and stream live with friend

FREESTYLE
READY
Apply custom filters on your games while you p

SETTING UP NVIDIA REFLEX LATENCY ANALYZER

Getting the Reflex Latency Analyzer running takes some work.

Nvidia is releasing a new version of GeForce Experience this week that supports the technology. To see the new RLA overlay,



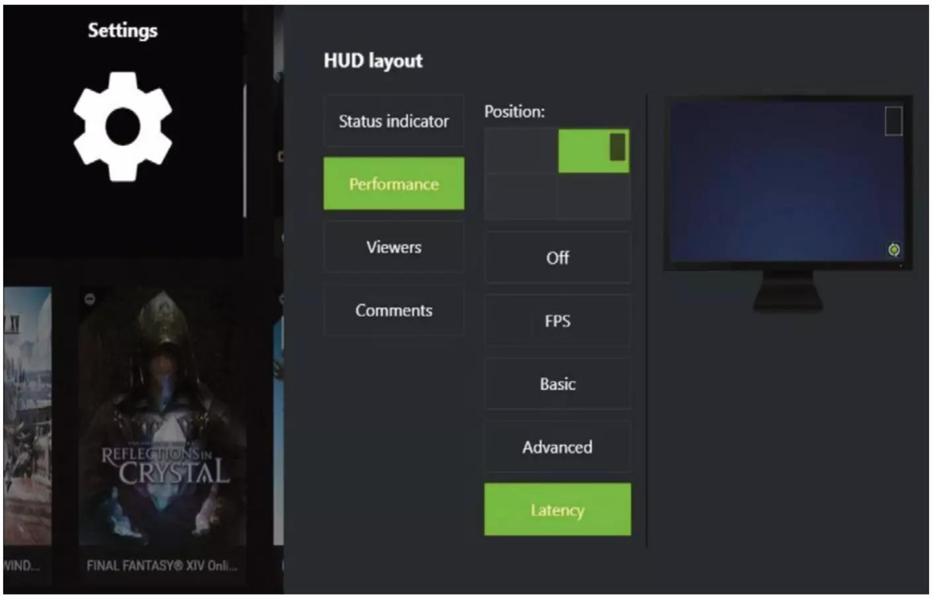
GeForce RTX 3090

GPU CLOCK	GPU TEMPERATURE	GPU VOLTAGE	GPU UTILIZATION
495MHz	33°C	0.7Volt	12%
GPU POWER	**FAN SPEED**	**MEMORY CLOCK**	**CPU UTILIZATION**
78Watts	0RPM	810MHz	26%

Performance Overlay (Alt+R) Off

Tuning Type Automatic

Click the gear icon.

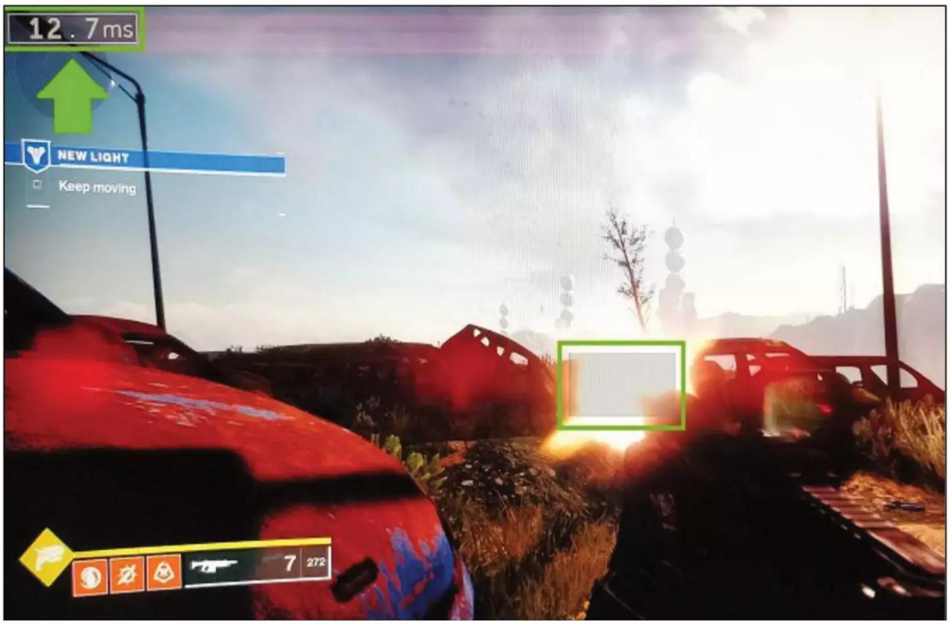

Settings
HUD layout
Status indicator
Performance
Viewers
Comments
Position:
Off
FPS
Basic
Advanced
Latency
REFLECTIONS IN CRYSTAL
FINAL FANTASY® XIV Onli...
WIND...

How to set up Nvidia's Reflex Latency Analyzer overlay.

you'll need to enable experimental features in GFE, as well as the "in-game overlay" option.

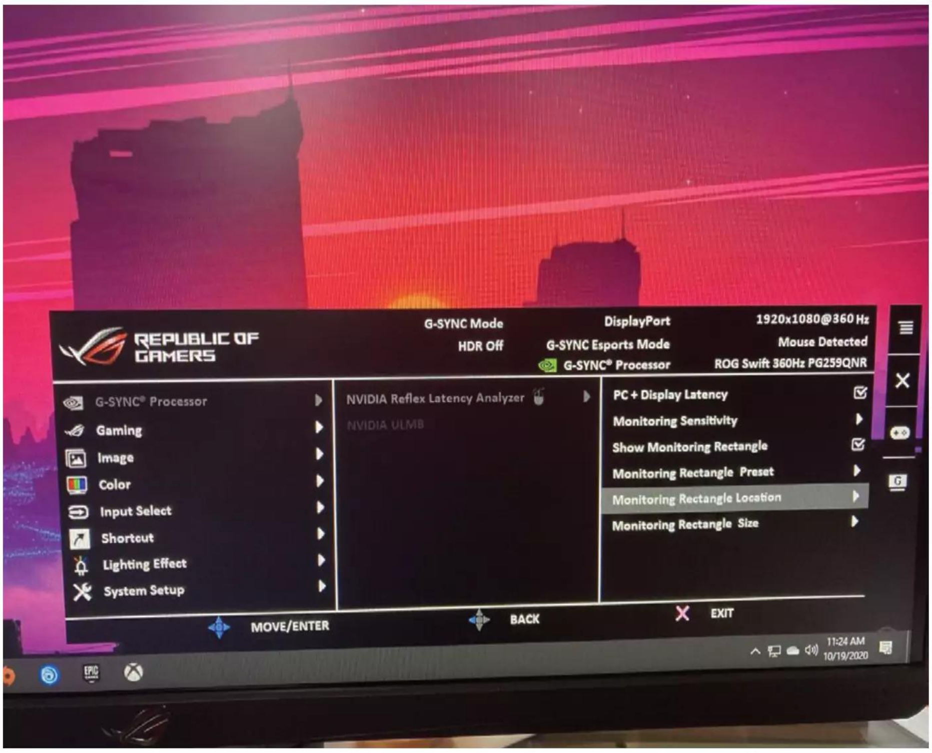
Once that's done, you need to press Alt + Z to summon the GFE overlay. Select the Performance option, and in the Performance tab that appears, click the tiny gear icon next to the "Performance overlay" option.

You'll see a lot of options. Select Performance, choose your overlay position, and select Latency. Now, when you press Alt + R the Reflex Latency Analyzer overlay will appear onscreen.


12.7ms
NEW LIGHT
Keep moving
7
272

This Nvidia-supplied screenshot shows the Reflex Latency Analyzer monitoring box over a muzzle flash in Destiny 2.

You also need to use your monitor's menu tools to tailor the technology to your specific games, and the specific animations you're tracking to measure latency. Reflex Latency Analyzer works by tracking the luminance of a specific part of the screen—typically a muzzle flash. It then calculates how long it takes for that area to change after you click your mouse, to determine overall system latency. Nvidia's Reflex SDK for games includes a "latency marker" option that displays a flashing box on the edge of the screen to make measurements easy and universal, but currently, only Fortnite supports it. In other games, you'll need to position the monitoring rectangle manually over your gun's muzzle flash (or whatever other animation you're measuring).


REPUBLIC OF GAMERS
G-SYNC Mode
HDR Off
DisplayPort
G-SYNC Esports Mode
G-SYNC® Processor
1920x1080@360 Hz
Mouse Detected
ROG Swift 360Hz PG259QNR
G-SYNC® Processor
Gaming
Image
Color
Input Select
Shortcut
Lighting Effect
System Setup
NVIDIA Reflex Latency Analyzer
NVIDIA ULMB
PC + Display Latency
Monitoring Sensitivity
Show Monitoring Rectangle
Monitoring Rectangle Preset
Monitoring Rectangle Location
Monitoring Rectangle Size
MOVE/ENTER
BACK
EXIT
11:24 AM
10/19/2020

You'll need to use your monitor's OSD to move the monitoring box around.

To do so, head into your monitor's menu and head to the G-Sync Processor option, then the Nvidia Reflex Latency Analyzer section. From there you'll see all the options you need to resize the monitoring rectangle and move it around as needed. Get it right over the center of your muzzle flash, and make it as small as possible in the center of the action. You don't want light bloom at the edges of the flashes affecting measurements if you can help it.

OUR TEST SETUP

Phew! Now that you know everything you need to know about Nvidia Reflex Low Latency Mode, the Reflex Latency Analyzer tool in new 360Hz G-Sync Esports monitors, and how they're totally unrelated to each other, let's use Latency Analyzer to measure metrics that we couldn't before. Are the Nvidia Reflex options in supported games worthwhile? Does upgrading to a more powerful GPU or faster monitor truly matter? How does dropping visual options to low affect responsiveness? Now we can measure it.

We benchmarked Nvidia Reflex on our standard graphics card testing system, which includes 32GB of RAM and an Intel Core i7-8700K overclocked to 5GHz on all cores. You can find the specifics here (go.pcworld.com/sphr). We tested the GeForce RTX 3080 as a high-end option, and the original GeForce GTX 1660 for a more mainstream comparison. We tested Valorant and Fortnite

The Asus ROG Chakram Core.

with Nvidia Reflex + Boost enabled.

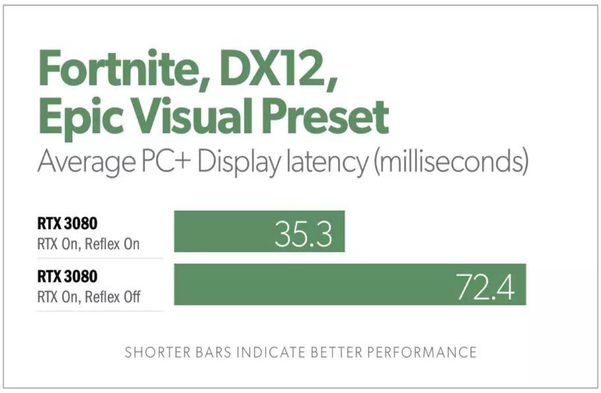
We hooked two mice up to the system: The Reflex-capable Asus ROG Chakram Core was plugged into the G-Sync module to measure mouse latency, and we put tape over the sensor to keep it from moving during testing. A secondary mouse was used for navigation to the testing spots. We set up repeatable testing scenarios in custom matches for each game, clicked the left mouse button to trigger an action, then waited for the animation to reset completely before doing it again. We did that 20 times, jotted down the average Mouse, PC + Display, and System Latency results, then repeated the process four more times. Each result below is the average of 100 clicks, in other words.

We kept an eye on the monitor's real-time latency metrics throughout the process. If any given click resulted in an abnormally high latency far outside of the norm, we stopped the measurements and restarted the 20-click process over. Variables in the game, like *Fortnite*'s day/night cycle or *Counter-Strike*'s random chickens, can introduce small, but noticeable variations in latency results if you aren't careful.

The numbers below show results from the PC + Display measurement. Part of Reflex Latency Analyzer's appeal lies in its mouse metrics and the overall system latency metrics those help provide, which isn't easily measurable with other means, but they're not especially helpful unless you have multiple mice to compare against each other. Our Asus ROG Chakram Core averaged a face-melting 0.5 millisecond latency time pretty much across the board, and in the two tests where it averaged higher, it only bumped up to 0.6ms. The real latency changes across our benchmarks occurred in the PC + Display measurement, so that's what we're focusing on.

NVIDIA REFLEX LATENCY BENCHMARKS

Let's start with *Fortnite*. Epic worked closely with Nvidia around the RTX 3080 launch, and *Fortnite* now supports the full Reflex SDK as well as real-time ray tracing and DLSS. The Nvidia Reflex SDK works best in GPU-bound scenarios, and activating ray tracing *without*



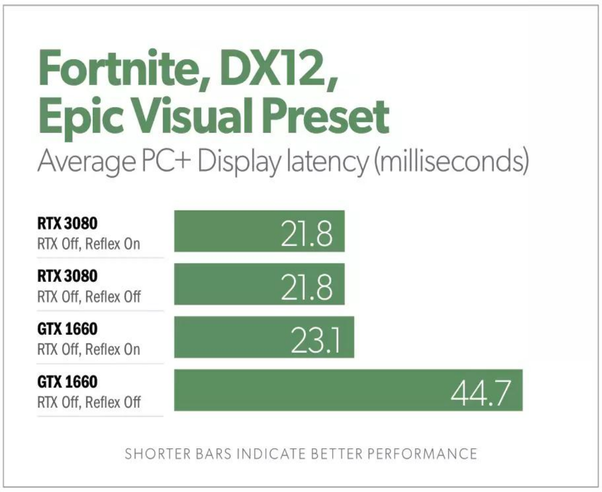
DLSS makes your graphics card sweat even at 1080p. First, let's take a look at how Nvidia Reflex can help with responsiveness.

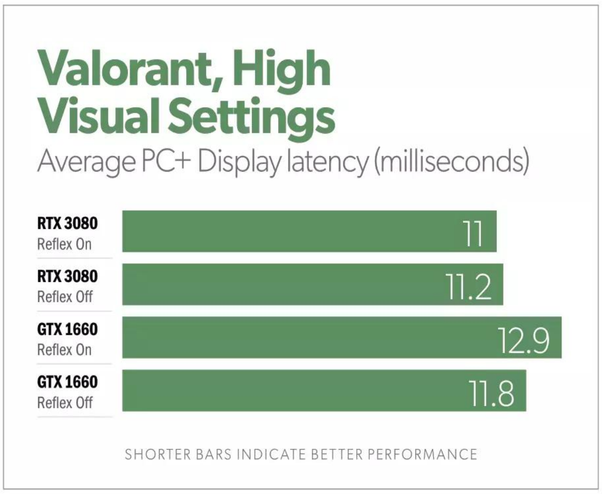
With the RTX 3080, using ray tracing to move the bottleneck from the CPU to the GPU can severely affect latency, but activating Nvidia Reflex claws back much of the pain. Flipping on Reflex results in a whopping *fifty-plus percent* latency improvement with RTX on, and it's a difference you can truly feel in the game. That's great news if you like playing with all the eye candy on, or prefer to use a higher 1440p or 4K resolution, which are more likely to become GPU-bound. With Reflex, you can have your cake and eat it too, at least to some degree.

Reflex doesn't deliver such sterling results if you aren't GPU-bound, however. With ray tracing turned off, the staggeringly powerful GeForce RTX 3080 becomes identically responsive with Reflex on or off.

Stepping down to the much more common GTX 1660 reveals Reflex's ongoing utility. That graphics card is nowhere near as powerful as the RTX 3080, and it can become GPU-bottlenecked at 1080p even with ray tracing disabled using the Epic visual preset. Turning Nvidia Reflex on significantly reduces latency with the GTX 1660 once again, bringing us down into the roughly 20-millisecond range considered optimal for competitive esports.

Riot's *Valorant* has taken the world by storm, and it's an incredibly well-optimized game. Even with visual settings maxed out at 1080p, *Valorant* remains incredibly responsive regardless of whether you have



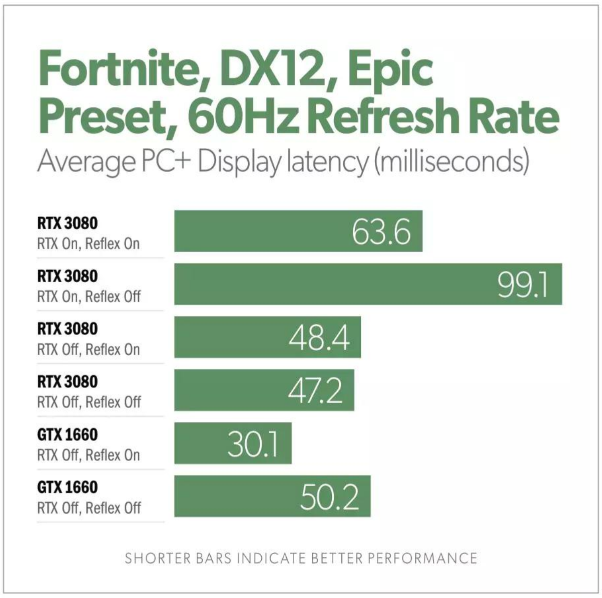


Nvidia Reflex on or off. To put these numbers in greater context, they're roughly twice as fast as the 20ms latency mark considered the competitive esports gold standard. If your game refreshes at 60 frames per second, that works out to a new frame every 13.3ms. These results are faster than *that*. Damn.

I'd expect there to be more effect if the resolution were boosted to 1440p or 4K, where the GPU comes more into play, but this is a 1080p panel. I was hoping to be able to use Nvidia's Dynamic Super Resolution feature to increase the render output to 4K, but Nvidia's experts warned me that doing so wouldn't create wholly accurate metrics, due to the slight overhead that DSR imparts. Alas.

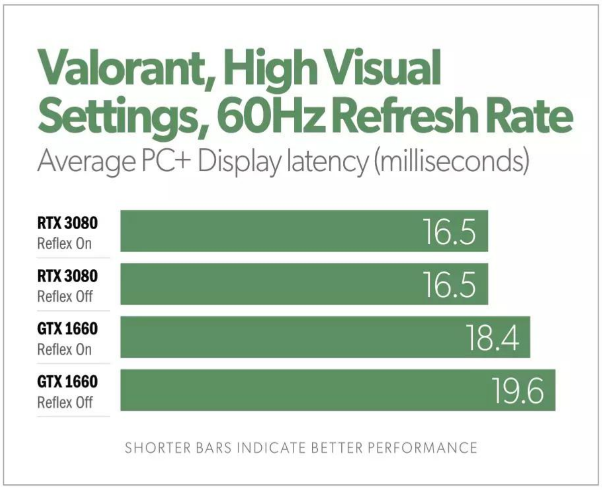
REFRESH RATES AND VISUAL SETTINGS IMPACT

But we can test more stuff. Those *Fortnite* and *Valorant* metrics were taken on a blistering 360Hz panel. Latency improves with higher refresh rates. Most people have a 60Hz display. How does using that more common refresh rate affect Reflex's capabilities? We locked the Asus ROG Swift PG259QNR's refresh rate to 60Hz using Nvidia Control Panel to find out. (We consulted with Nvidia to confirm that doing so wouldn't affect the Reflex Latency Analyzer's reliability.)


Fortnite, DX12, Epic Preset, 60Hz Refresh Rate

Average PC+ Display latency (milliseconds)

SHORTER BARS INDICATE BETTER PERFORMANCE

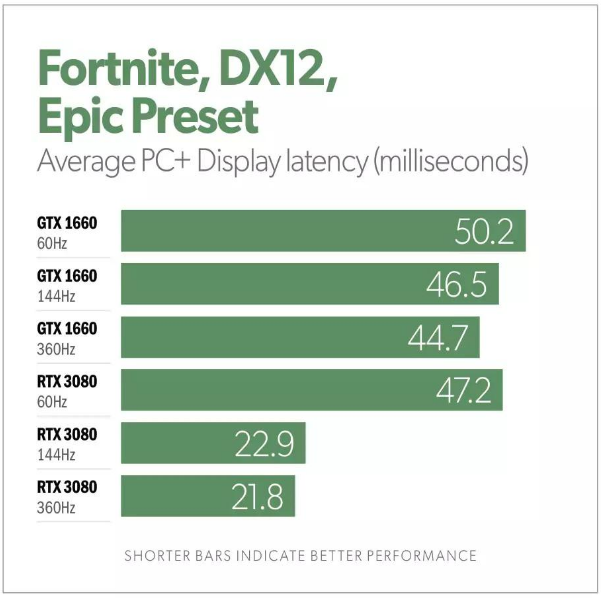

Valorant, High Visual Settings, 60Hz Refresh Rate

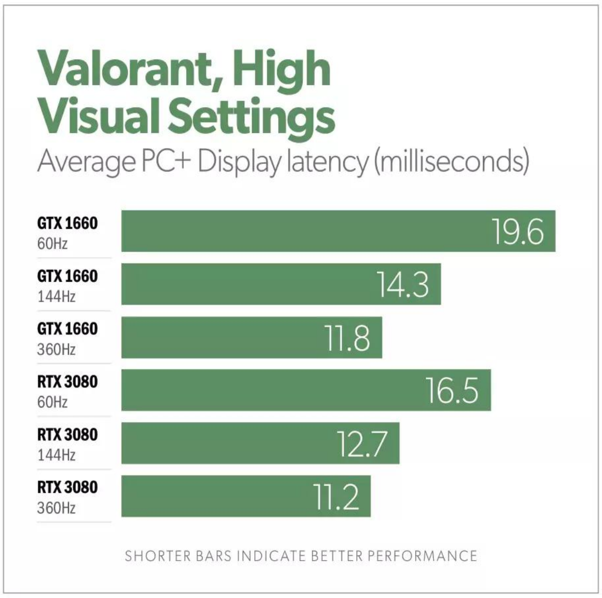
Average PC+ Display latency (milliseconds)

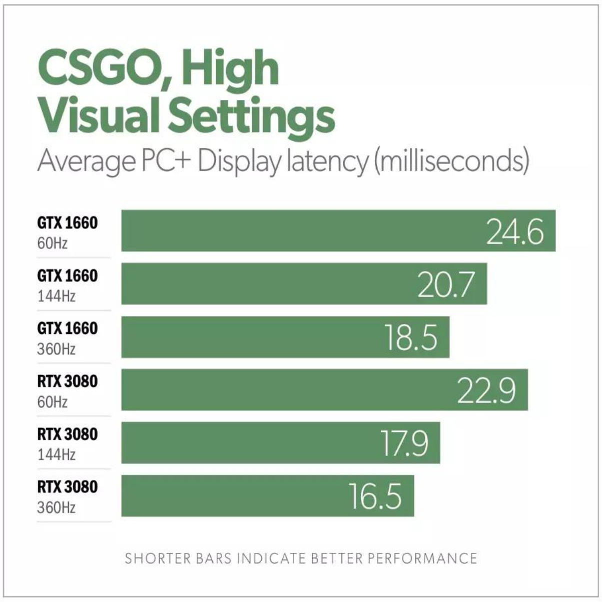
SHORTER BARS INDICATE BETTER PERFORMANCE

There are a handful of takeaways here. First, note how much less responsive these games become moving from a 360Hz to a 60Hz panel—there's a marked downgrade across the board compared to previous results. (We'll dive into that more later.) Reflex continues to help significantly for the GTX 1660 in *Fortnite*, as well as the RTX 3080 with ray tracing enabled. *Valorant*'s responsiveness remains largely unaffected with Reflex active at 1080p.

Let's keep that train of thought choo-chooing. We also tested *Fortnite* and *Valorant* with the monitor locked at 60Hz, 144Hz, and 360Hz refresh rates to illustrate the advantage



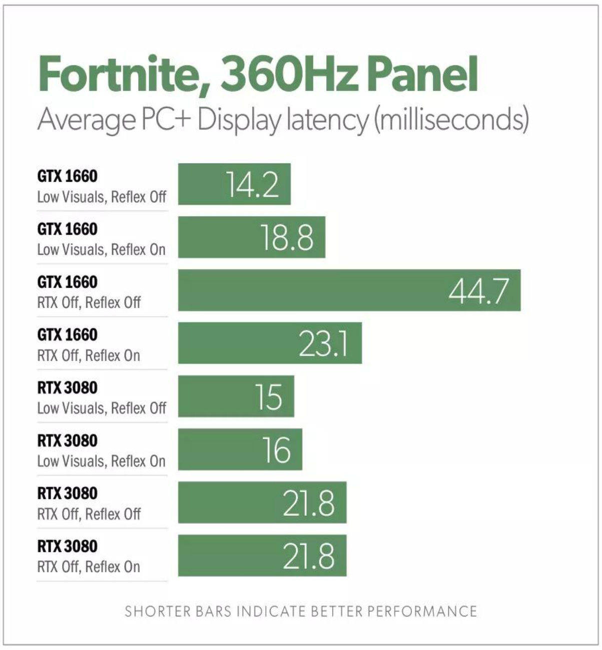


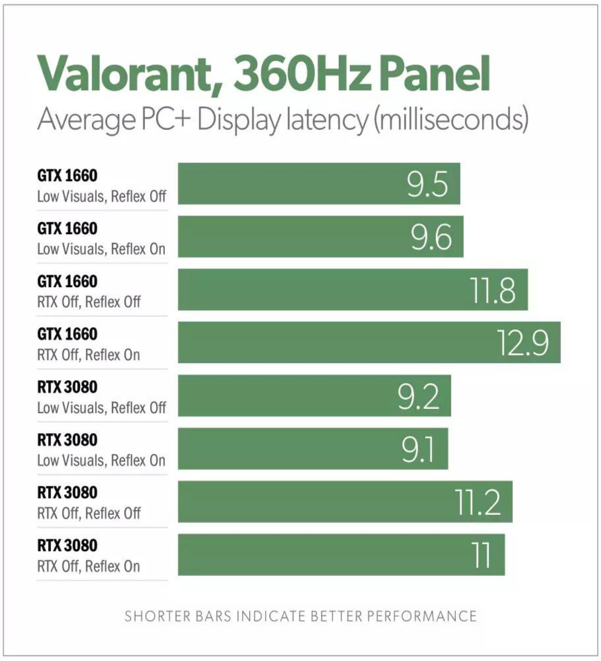


that faster displays provide. We also threw in *Counter-Strike: Global Offensive* because it's massively popular—and to drive home the fact that Nvidia Reflex and Reflex Latency Analyzer are mutually exclusive. CSGO doesn't support the Nvidia Reflex Low Latency Mode APIs, but you can still measure its latency (and the latency of any game) with Nvidia's tools. We tested all three games with the highest visual settings possible, with Reflex *off* and ray tracing disabled in *Fortnite*.

Latency scales down as refresh rates go up, as you'd expect. While upgrading to a 360Hz monitor definitely provides more responsiveness, 144Hz seems like the sweet spot, with diminishing returns thereafter—especially if you're playing esports games with an ultra-potent GPU like the RTX 3080.

Now let's do something completely different. We've been testing these titles with maxed-out graphics settings to test the effectiveness of Nvidia Reflex, which kicks in harder the heavier your GPU is being utilized. But many competitive esports players play the exact opposite way, cranking *down* all the visuals to improve frame rates and response times. How does Nvidia Reflex hold up versus that standard? We tuned back *Fortnite* (with ray tracing off) and *Valorant* to find out, using the panel's full 360Hz speeds.





As you can see, playing with low visual settings remains the most responsive option. With the CPU being the bottleneck at that point, Nvidia Reflex's benefits are essentially null in standard circumstances. It even seemingly adds a bit of latency with the GTX 1660 on a 360Hz panel in *Fortnite*—though 18.8ms remains firmly in the "competitive-grade esports" category.

There are two considerations to keep in mind, though. First, the bottom-rung visuals are ugly: jagged edges, low-res textures, you name it. Boosting the visuals up higher to get rid of that is worthwhile for everyone but the most competitive gamers, and Nvidia Reflex helps you claw most of the responsiveness back.

Second, even when you drop all visuals to low to make the CPU your bottleneck, some scenes in some games can still become GPU-bound. Nvidia's Seth Schneider highlighted a close circle toward the end of an *Apex Legends* map. When people start chucking thermite grenades, the game can suddenly flip to being GPU-bound, and having Nvidia Reflex on can greatly help with responsiveness in that scenario, he says.

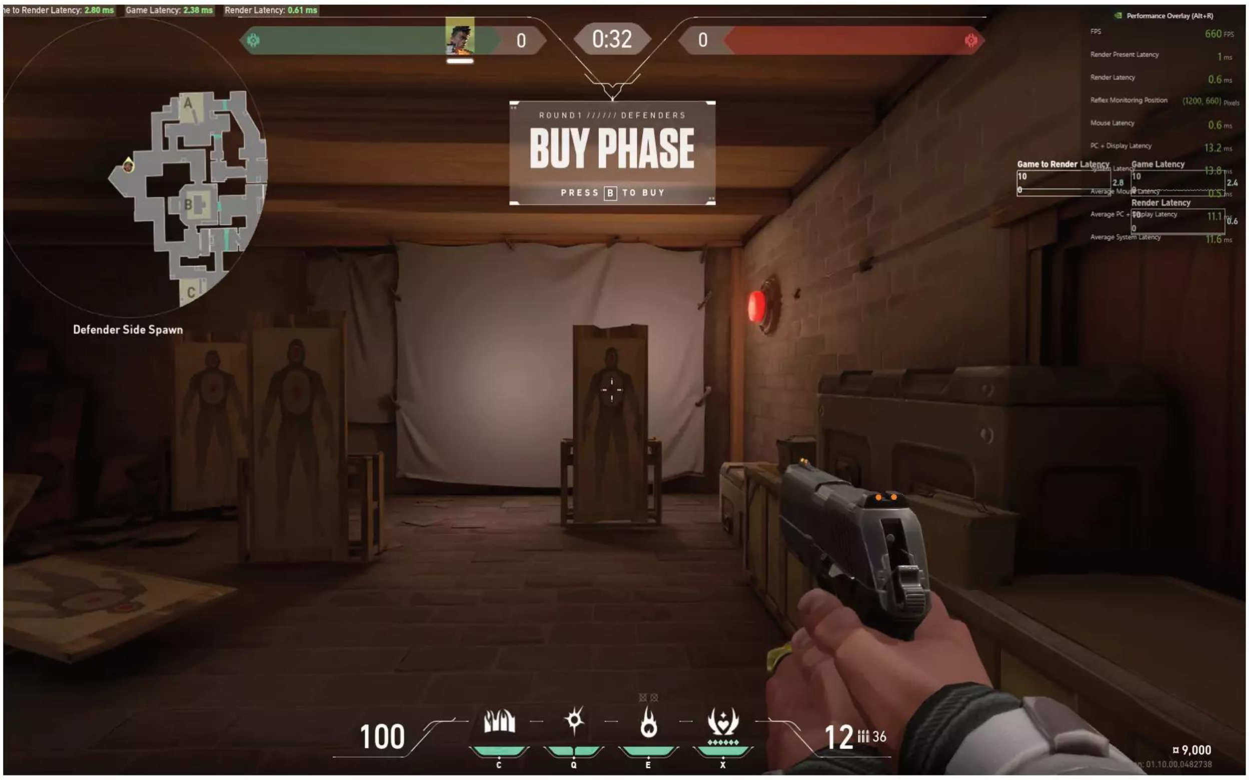
BOTTOM LINE

That was a long ride full of interesting findings. Hopefully you understand the differences between the Nvidia Reflex feature found in games and the Reflex Latency Analyzer found in monitors now. Like I said, they're two very different tools with two very different uses, but both can help you become a better esports player.

First, let's discuss the Nvidia Reflex Low Latency Mode feature in games. It won't help you across the board, but it can improve latency *significantly* if you become GPU-bound, roughly doubling responsiveness in situations where your graphics card is stressed. That's *huge* for casual esports gamers. Nvidia Reflex can let you bump up visual details while keeping your games responsive. That's an all-around win for your gaming experience. Better yet, activating Reflex never really hurts responsiveness. There's no reason *not* to turn it on. This is a fantastic technology that can give you a real edge over your competition, as studies have shown that player accuracy and kill-to-death rates improve as latency goes down.

I suspect Reflex would be even more beneficial at 1440p and 4K resolutions, but the panel we used for testing is a 1080p display, and we need its analyzing tools to measure latency metrics. (We'd love to see 1440p, 144Hz monitors with Reflex Latency Analyzer inside.) Definitely try it though; since they've integrated the Reflex API, both *Fortnite* and *Valorant* now include an option to show some latency metrics onscreen in the game itself. You can use those to see if turning Reflex on makes a difference on your system even if you don't have a 360Hz G-Sync Esports display, and to be honest, you'll probably feel it if Reflex drops latency significantly. It's very noticeable in the Fortnite scenarios that show the biggest improvements.

Speaking of those 360Hz G-Sync Esports monitors, they're also very useful, but aiming for a very different crowd—very competitive and deep-pocketed esports fanatics. Asus hasn't announced pricing for the luxurious



ne to Render Latency: 2.80 ms Game Latency: 2.38 ms Render Latency: 0.61 ms

Performance Overlay (Alt+R)

FPS 660 FPS
Render Present Latency 1 ms
Render Latency 0.6 ms
Reflex Monitoring Position (1200, 660) Pixels
Mouse Latency 0.6 ms
PC + Display Latency 13.2 ms
System Latency 13.8 ms
Average Mouse Latency 0.5 ms
Average PC + Display Latency 11.1 ms
Average System Latency 11.6 ms

You can see *Valorant's* native latency monitoring graphs underneath the RLA overlay in this screenshot.

ROG Swift PG259QNR display we used for testing, but the non-"R" ROG Swift PG259QN model (go.pcworld.com/259q) that lacks Reflex Latency Analyzer capabilities costs $700. Expect to pay more for this fancier model.

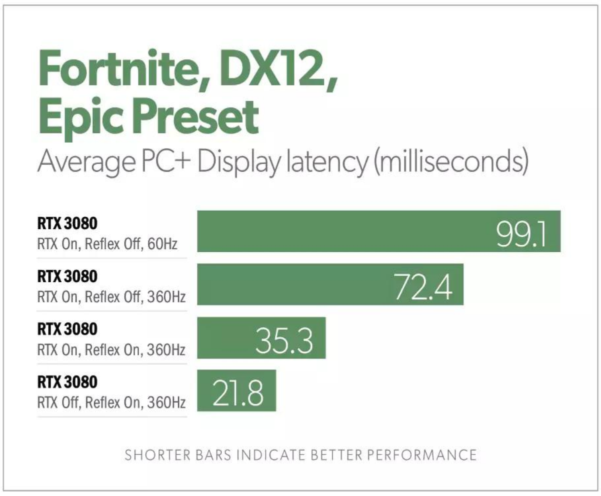
You get a lot for your money, though. Playing on a 360Hz IPS monitor is simply sublime. Everything feels so *smooth*. Both the visual quality of the panel and the build quality of Asus's monitor are top notch. This thing rocks. Reflex Latency Analyzer is almost just a value-adding cherry on top.

That's generally where I fall on Reflex Latency Analyzer for actual gamers. The technology is wonderful for reviewers like myself, allowing us to test the variety of latency scenarios we walked through earlier. For normal people and casual gamers, it's overkill.

But if you're the sort of person who is willing to invest hundreds and hundreds of dollars into a 360Hz display for peak competitive performance anyway, you'll probably find Reflex Latency Analyzer invaluable. Being able to see the latency impact created by hardware changes and by tweaking specific visual settings in games can help you fine-tune things so your game looks good *and* feels great, especially if you're using the Nvidia Reflex Low Latency Mode in games. There's a lot you could play with. Nvidia's Reflex Latency Analyzer is a godsend for optimization geeks.

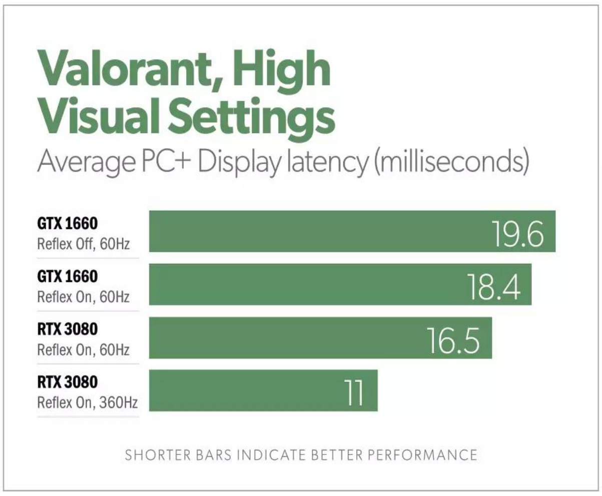
A big part of the appeal lies in Reflex Latency Analyzer's ability to measure mouse responsiveness for true end-to-end system latency, but that's the least compelling reason to buy in, at least for now. Yes, measuring

You need to plug your mouse into a specific USB port on the rear of your monitor to use Nvidia's Reflex Latency Analyzer.



Fortnite, DX12, Epic Preset

Average PC+ Display latency (milliseconds)



Valorant, High Visual Settings

Average PC+ Display latency (milliseconds)

system latency used to take much more equipment. But today, only four mice support Reflex Latency Analyzer. Once I realized the Asus ROG Chakram Core mouse included in my reviewer kit delivered 0.5ms of average latency across the board, I couldn't really do anything else with the information. It just is what it is. Once more mice add Reflex Latency Analyzer support, or once Nvidia adds a wider array of average latency data for unsupported mice to its database, the feature will be more compelling. (Currently, Nvidia's database provides average click latency data for the top 30 esports mice, as tabulated by ProSettings.net (go.pcworld.com/pset), with plans to add more.)

This ROG Chakram Core (go.pcworld.com/chak) is just as potent as the 360Hz ROG Swift monitor, though. Top-tier gaming mice, including the others with Reflex Latency Analyzer support, take several milliseconds to register a click. The ROG Chakram Core sends its signals in half a millisecond. It's insane, and you can feel it in moment-to-moment gameplay. If you're a competitive esports gamer, check it out even if you aren't interested in the 360Hz G-Sync Esports display ecosystem.

Bottom line? Nvidia Reflex can help make you a better esports gamer, regardless of which facet you're examining. The Nvidia Reflex Low Latency Mode feature can *drastically* improve responsiveness if you like games to both look good and feel great. There's no reason not to turn it on. The Reflex Latency Analyzer in 360Hz G-Sync Esports monitors serves a much more niche crowd and needs fuller ecosystem support to truly shine, but if you're invested in esports enough to even consider picking up a 360Hz panel, you'll find it an invaluable tool in your tinkering. We're excited by what Nvidia's trying to nurture here.

If you want to go even deeper down the latency rabbit hole, this highly technical Nvidia explainer (go.pcworld.com/nxpl) describing the Reflex suite of technologies is highly recommended.

Sabrent Rocket 4 Plus NVMe SSD: Fast on PCIe 4, fast on PCIe 3

The 2TB version of this SSD is nearly as fast with large files as Samsung's 980 Pro, and considerably less expensive. **BY JON L. JACOBI**

PCWorld EDITORS' CHOICE

Sabrent must've read some of my articles and discovered my love of the color copper. The heat-spreader and the metal carrying case for the brand-spanking-new Rocket 4 Plus PCIe 4 NMVe SSD feature the color in copious amounts. I like it. Even if copper leaves you flat, the drive's stellar performance will grab your attention—it bested the Samsung 980 Pro (go.pcworld.com/s980) in many tests.

SPECS AND PRICING

The NVMe SSDs we review all use the M.2 connector, and are 22mm wide by 80mm long (2280). The Rocket 4 Plus is an x4 PCIe 4.0 device featuring a Phison PS5018-E18 controller and 96-layer, Micron TLC NAND.

IMAGE: SABRENT

ROCKET 4 PLUS
ADVANCED PCIe 4 M.2 SSD
SABRENT
2TB
DEVELOPED BY SABRENT IN USA

Sabrent's Rocket 4 Plus lives up to its name, rivaling the best across both the PCIe 3 and PCIe 4 buses.

Sabrent promises not to change to slower components, as has happened with a couple of SSD vendors recently (go.pcworld.com/slcm). There's also 2MB of DRAM cache. NAND is treated as SLC for secondary caching to the tune of 25 percent.

Beyond that, the drive is enveloped in coppery goodness (the label) and is available in two flavors: 1TB ($199.98 on Amazon; go.pcworld.com/q199) and 2TB ($400 on Amazon; go.pcworld.com/a399). A 500GB model exists but is hard to fine online, and a 4TB flavor will ship eventually.

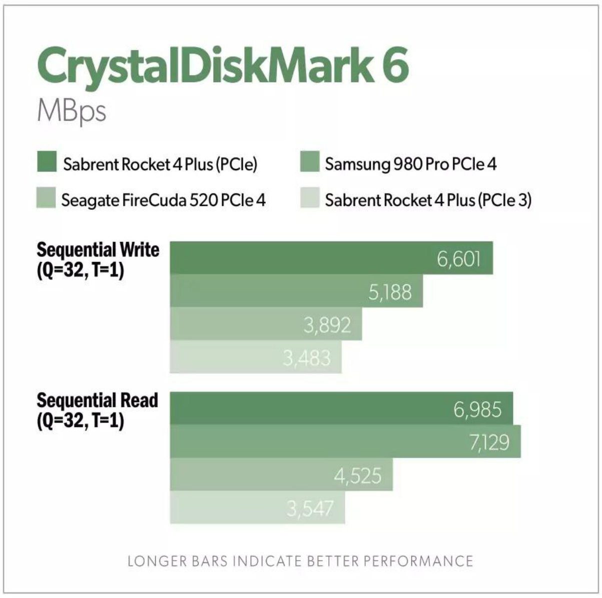
The drives carry a 5-year warranty, and are rated for 350TBW per 500GB of capacity. TBW is the number or terabytes that may be written before the drive warranty lapses. It's quite likely capable of writing more, but that's the company's cut-off point for replacement. Most users are unlikely to come close to that in a decade.

PERFORMANCE

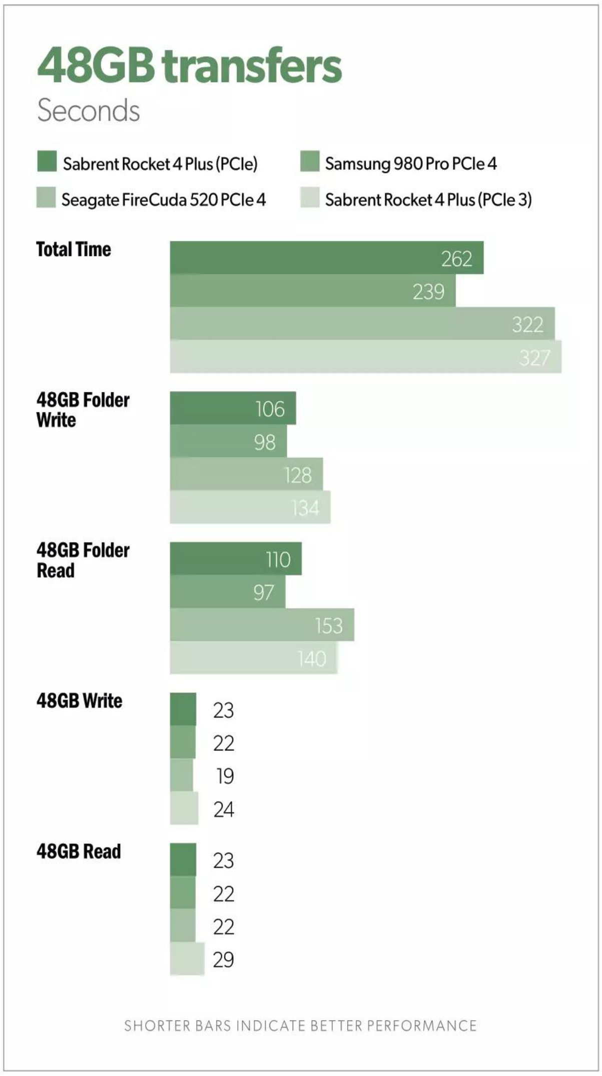
All that coppery goodness would mean nothing if the Rocket 4 Plus didn't haul the freight. The 2TB version I tested delivers. The

ROCKET 4 PLUS
ADVANCED PCIe 4 M.2 SSD
SABRENT
1TB
DEVELOPED BY SABRENT IN USA

The Sabrent's stellar performance will grab your attention.



The Rocket 4 Plus's CrystalDiskMark 6 sustained throughput numbers are impressive indeed.



The Rocket 4 Plus turned in a very good performance with 48GB Windows transfers though it couldn't match the Samsung 980 Pro.

Rocket 4 Plus's CrystalDiskMark 6 sustained throughput numbers are impressive indeed, trading first place between writing and reading with the Samsung 980 Pro (go.pcworld.com/s980).

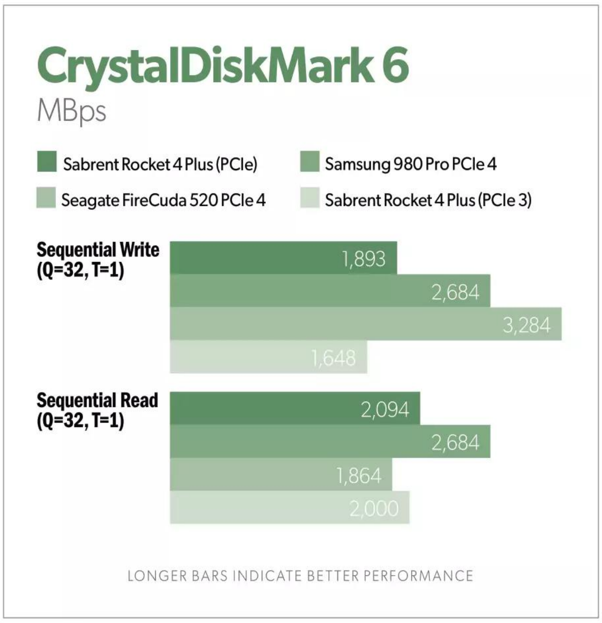
The Rocket 4 Plus couldn't quite match the 980 Pro's overall real world performance in our 48GB transfer tests, but it took a solid second place.

CrystalDiskMark's 4K tests showed another story—the Rocket 4 Plus lagged significantly.

Where the 2TB Rocket 4 Plus really rocked was in our 450GB sustained write tests. Note however, that the 980 Pro Samsung sent me was only a 1TB model. Though it's not shown in the charts, the 1TB version dropped to around 675MBps (PCIe 3) at around the 350GB mark in the copy and took 386 seconds, compared to the 2TB version's 250 seconds on PCIe 3 and 209 seconds over PCIe 4. Yes, cache makes a difference.

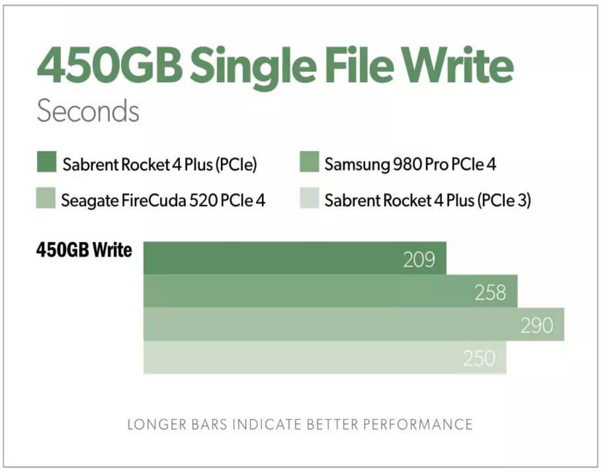
I should also mention that in general, it's never a good idea to run an SSD close to capacity. Write speeds will slow down tremendously without NAND available as cache. Always overbuy in terms of capacity.

The PCIe 3 tests utilized Windows 10



As you can see, the Sabrent Rocket 4 Plus was no match for the Samsung 980 Pro with 4K files. It was also bested in writes by the Seagate FireCuda 520.

64-bit running on a Core i7-5820K/Asus X99 Deluxe system with four 16GB Kingston 2666MHz DDR4 modules, a Zotac (Nvidia) GT 710 1GB x2 PCIe graphics card, and an Asmedia ASM2142 USB 3.1 card. It also contains a Gigabyte GC-Alpine Thunderbolt 3 card, and Softperfect Ramdisk 3.4.6 for the 48GB read and write tests.



The 2TB Rocket 4 Plus wrote 450GB faster than its 980 Pro rival, though the latter was only 1TB. The 1TB Rocket 4 Plus took 358 seconds.

The PCIe 4 testing was done on an MSI MEG X570 motherboard socketing an AMD Ryzen 7 3700X 8-core CPU, using the same Kingston DRAM, cards, and software. All testing is performed on an empty, or nearly empty drive. Performance will decrease as the drive fills up.

BOTTOM LINE

Though there's room for improvement in small- and 4K file performance, there's little else to complain about with the Sabrent Rocket 4 Plus in its 2TB incarnation. That it can wrestle at all with the 980 Pro at this price point is a feather in Sabrent's (and Phison's) cap.

Sabrent Rocket 4 Plus NVMe SSD (2TB)

★★★★½

PROS

- Excellent performance.
- Exceptional sustained writes from the 2TB version.
- Nice-looking copper color scheme.

CONS

- 1TB version ran out of cache before the end of our 450GB write.

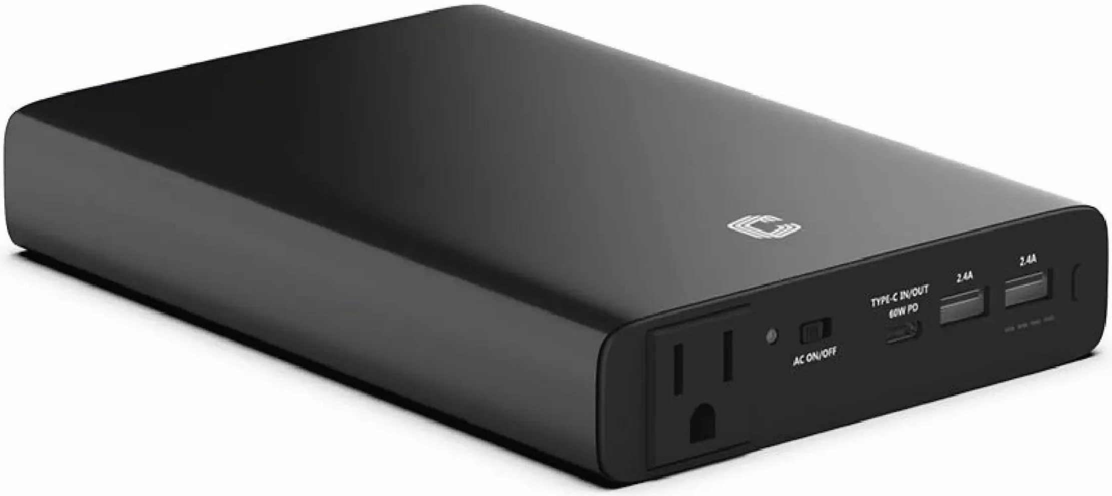
BOTTOM LINE

This drive is a worthy competitor to Samsung's 980 Pro, at least in the 2TB version. The 1TB will run out of juice on very long writes, something the 980 Pro won't do. Regardless, for the price, an excellent SSD.

$399

ChargeTech Portable Power Outlet AM 27K 4.0: Part battery pack, part power station

It even sports an antimicrobial film. **BY JASON CIPRIANI**



The ChargeTech Portable Power Outlet AM is a mix between a portable battery pack, albeit a big one, and one of the more robust and capable power stations. It includes several USB ports and a standard wall outlet capable of providing up to 100W of power.

It's more expensive than a typical battery pack, priced at $199 most of the time, but can be found on sale for as low as $149. The "AM" version that I received is sheathed in an antimicrobial film that ChargeTech says will prevent viruses and bacteria from growing on the outside of the pack. (The microbe-friendly version of the Portable Power Outlet is slightly cheaper, with a regular price of $159 [go.pcworld.com/r159], but on sale for $139.)

With a total capacity of 96.48Wh, or 27,000mAh, the pack has enough capacity to charge your phone several times or add a few hours of extra use to your laptop. There are a total of four ports on the front of the pack. From the left, there's a standard 110V outlet accompanied by an on/off switch; there's a USB-C port that's used for charging devices or charging the pack; and there are two 2.4a USB ports. There's also a button you can press to activate four indicator lights that represent how much charge the pack has.

One minor complaint I have with the design is that the outlet's on/off label is backward. When I move the switch to the left,

IMAGE: CHARGETECH

which is the side where "On" is, the outlet is actually off. And when the switch is moved to the right, where "Off" is located, the outlet is turned on. The label is only there to let you know what the switch does—turn the outlet on or off—but the positioning of it is confusing. Thankfully, there's a small indicator light that turns green when the outlet is on, and red as the battery gets low. To use one of the USB outlets, you simply plug something in. The pack will recognize it and start charging on its own. You can even charge the pack and another device at the same time.

As we do with all of our battery pack tests, we used the AVHzY USB Power Meter to verify the output of all three ports on the Portable Power Outlet. Both USB-A ports triggered the Apple 2.4A charging standard, and that's it. We suspect ChargeTech didn't include support for other standards, like QC 2.0 or QC 3.0, because there's an outlet you can use with your smartphone's standard wall adapter to get fast charging. We also verified that the USB-C supports Power Delivery at up to 20V/3A, or 60W.

Charging the Portable Power Outlet is done via the USB-C port, which can accept up to 60W. Included in the box is a wall adapter and USB-C cable, but the adapter maxes out at 30W. While it's a nice bonus to have an adapter that will charge the device, it would have been nice to have a 60W adapter to ensure it charges at full speed.

It took a total of one hour and 48 minutes to fully charge the device at the full 60W speed. You can assume it'll take roughly twice that long when using the included 30W adapter. Either way, it's nice that the pack charges so fast. I've tested packs with a third of this capacity that have taken as long or longer to charge. Support for 60W is no joke.

I fully depleted the 96.48Wh capacity pack using the same adapter to record how much power was used before the pack turned off. The end result was 81.49Wh of output, giving the Portal Power Outlet an 84.15 percent efficiency rating. That's the highest out of similar battery packs I've tested, like the Sherpa100AC (go.pcworld.com/shpa), which tested at 78.78%.

To test the outlet, I connected a desk lamp to the fully charged battery and used a camera to monitor how long the light stayed on. This is a new lamp, so I don't have numbers to compare it to, but the battery pack lasted seven hours and 42 minutes before the light turned off. That's more than enough to light up a room during a power outage while also charging your phone.

ChargeTech Portable Power Outlet AM 27K 4.0

★★★★☆

BOTTOM LINE

ChargeTech's Portable Power Outlet AM 27K 4.0 is the first power bank we've tested that's pandemic-ready—meaning it comes sheathed in an antimicrobial film. It's also well equipped to serve in an emergency.

$399

GRAPHICS CARDS ARE ABOUT TO GET A *LOT* MORE EXPENSIVE, ASUS WARNS

MOTHERBOARDS, TOO.

BY BRAD CHACOS

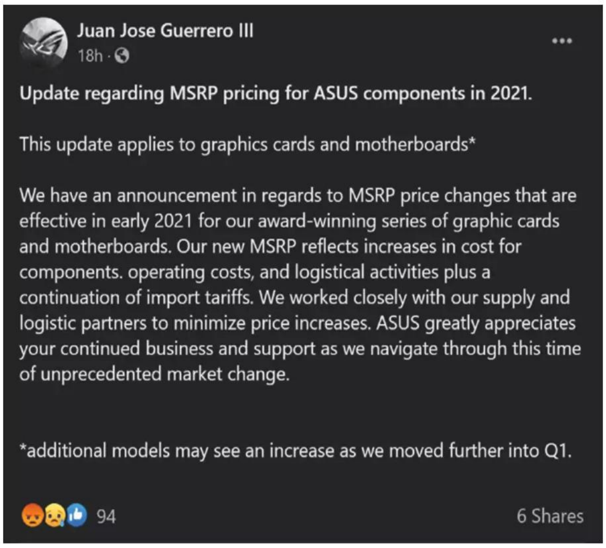
TUF GAMING
ASUS

Ever since Nvidia's GeForce RTX 30-series and AMD's Radeon RX 6000-series graphics cards launched last fall, the overwhelming demand and tight supply, exacerbated by a cryptocurrency boom (go.pcworld.com/boom), has caused prices for all graphics cards to go nuts. Brace yourself: It looks like it's about to get even worse.

In the Asus DIY PC Facebook group, Asus technical marketing manager Juan Jose Guerrero III warned (go.pcworld.com/jogu) that prices for the company's components will increase in the new year.

"We have an announcement in regards to MSRP price changes that are effective in early 2021 for our award-winning series of graphic cards and motherboards," Guerrero wrote, though he warned that "additional models" may also wind up receiving price increases as well. "Our new MSRP reflects increases in cost for components, operating costs, and logistical activities plus a continuation of import tariffs. We worked closely with our supply and logistic partners to minimize price increases. ASUS greatly appreciates your continued business and support as we navigate through this time of unprecedented market change."

Yikes. It's not a small bump, either. WCCFTech (go.pcworld.com/wcft) found the liquid-cooled ROG Strix Radeon RX 6800 XT



Juan Jose Guerrero III

18h ·

Update regarding MSRP pricing for ASUS components in 2021.

This update applies to graphics cards and motherboards*

We have an announcement in regards to MSRP price changes that are effective in early 2021 for our award-winning series of graphic cards and motherboards. Our new MSRP reflects increases in cost for components. operating costs, and logistical activities plus a continuation of import tariffs. We worked closely with our supply and logistic partners to minimize price increases. ASUS greatly appreciates your continued business and support as we navigate through this time of unprecedented market change.

*additional models may see an increase as we moved further into Q1.

94

6 Shares

LC going for a staggering $1,080 at Newegg (go.pcworld.com/10nw), compared to a $900 launch price. The Asus TUF Radeon RX 6800 XT launched at $810, but now lists for $970 at Newegg (go.pcworld.com/97nw).

Those increases aren't upcharges by Newegg, either. Videocardz (go.pcworld.com/vcrz) found a wide swath of GeForce RTX 30-series graphics cards now listed at much higher prices on Asus's own website. The Asus ROG Strix RTX 3080 launched at $850, for example (and is still showing at that price on Best Buy's website [go.pcworld.com/bbwb]), but is now listed at $930 on Asus's website (go.pcworld.com/aswb), as well as B&H Photo (go.pcworld.com/bhwb) and Newegg (go.pcworld.com/nwwb). Other GPUs see similar markups. The Asus TUF RTX 3060 Ti we reviewed (go.pcworld.com/60rv)—and loved—at $460 now costs $530 at Newegg (go.pcworld.com/53nw), making it more expensive than the step-up $500 GeForce RTX 3070 Founders Edition (go.pcworld.com/7fnd).

The pricing comparison between the TUF RTX 3060 Ti and Nvidia's RTX 3070 Founders Edition may wind up being academic. Asus is one of the largest manufacturers of PC components, with fingers in practically every DIY pie. If it's increasing prices due to international shipping logistics and tariff issues, don't be surprised to see the same from other vendors soon. We've heard from numerous sources at hardware vendors and system integrators about the sky-high cost of doing business right now. If you thought 2020 was tough, 2021 looks even bleaker for PC gamers itching to upgrade their rigs for Cyberpunk 2077 (go.pcworld.com/cp77). Fingers crossed this insanity settles down sooner rather than later.

ASUS
PRIME
X570-P

Asus says motherboards will see price increases in 2021 as well.

I didn't talk for a very long time

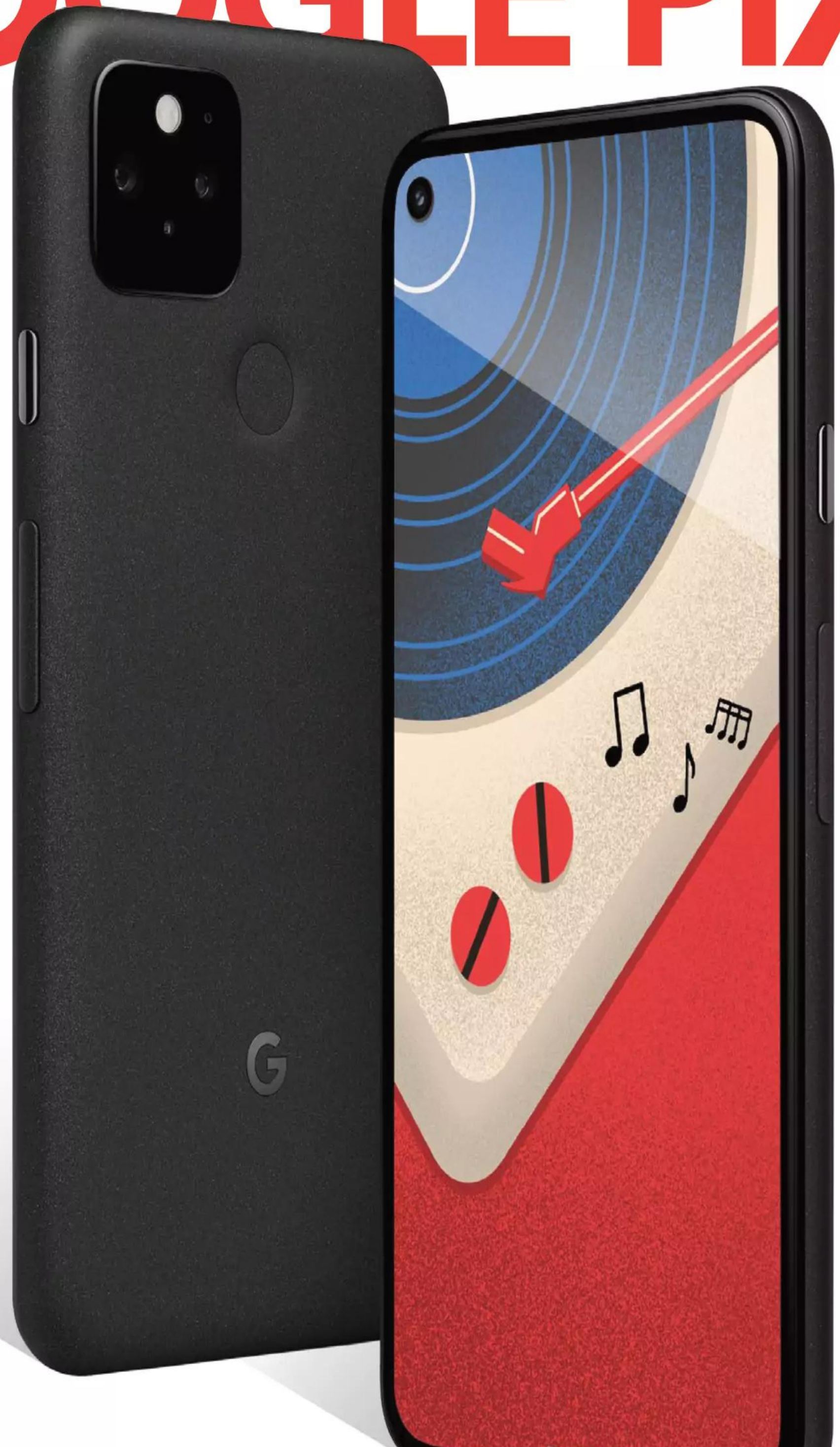
Jacob Sanchez
Diagnosed with autism

Lack of speech is a sign of autism. Learn the others at autismspeaks.org/signs.

AUTISM SPEAKS®

WHY 2021 COULD FINALLY BE

THE YEAR OF THE GOOGLE PIXEL



THE SURPRISING PIXEL 5 COULD LEAD TO BIGGER THINGS FOR GOOGLE’S PHONE STRATEGY.

BY MICHAEL SIMON

This time last year I wrote a column titled, "If you got a Pixel 4 for Christmas, you should probably return it (go.pcworld.com/p4xm)." I didn't want to write it. Ever since the Pixel launched in 2016, I've rooted for Google's phone to succeed. No other company is in such a position to bring an iPhone-like level of hardware/software integration and an experience unsurpassed on any other Android phone.

Unfortunately Google never quite nailed it. The pieces were all there—flagship processor, fantastic camera, regular Android updates—but the design always left much to be desired, the features were gimmicky, and the battery was merely good-enough. On the Pixel 4, the compromises became too much to bear.

But things might be looking up. In 2020 Google switched up its strategy with the Pixel 4a and 5, and the results were shockingly good. For one, the design was fantastic, with a light frame, slim bezels, and a textured non-glass back. But the more interesting moves were inside the phone: Google opted for the midrange Snapdragon 765G rather than the 865, and the Pixel didn't lose a step. It still feels speedy, still delivers the purest Android experience, and still takes better photos than phones costing hundreds of dollars more. It also opens up the Pixel to a new world of possibilities.

LOWER-END, HIGHER-CLASS

The Pixel might have been just a gleam in Google's eye when Android One launched

11:00
11:00
11:00
11:00

Previous Pixel phones never had the right formula.

back in 2014 (go.pcworld.com/and1), but the two projects are cut from the same cloth. The vision of Android One was to bring a pure Android experience to lower end phones that were often filled with bloatware. The Pixel phones are basically high-end Android One phones. Even with better components and displays, the focus—and selling point—is on software.

That software emphasis, however, is largely why the early Pixel phones failed to make much of an impact. The designs didn't match the high cost, especially when compared to similarly priced handsets from Apple and Samsung. That's why the Pixel 3a and 4a have fared better in terms of sales (go.pcworld.com/btsl): The lower prices just make more sense.

With the Pixel 4a, 4a 5G, and 5, Google is creating a better balance between the hardware people want and the software they need. With Android One (go.pcworld.com/adon), Google was "working closely with phone and silicon chip makers…to build phones that are not just great to use, but also affordable," a mantra that has found its way into the 2020 Pixel lineup. It's more than just a lower price point or slower chip. For what seems like the first time in a Google phone, the Pixel 5 phone is built solely to leverage the power of Android without worrying about high-end parts and high-priced competitors.

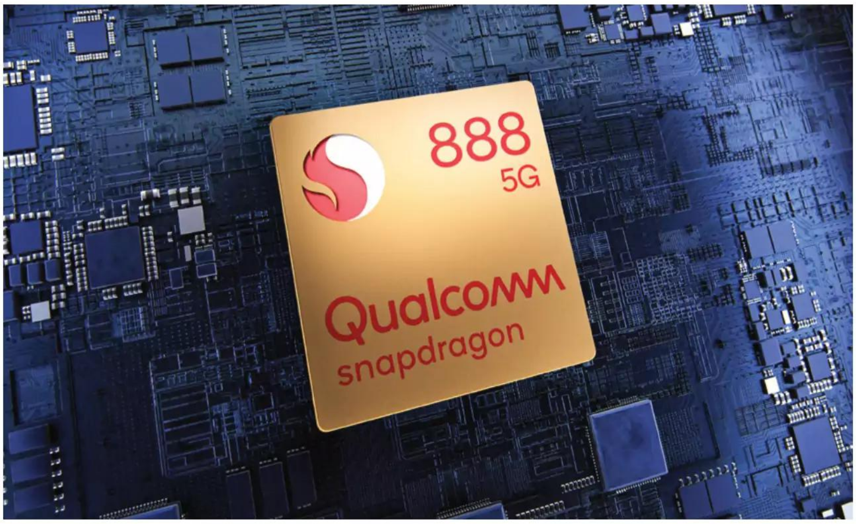
The Pixel 6 could take it even further. The lineup this year was a little confusing with the $499 Pixel 4a 5G and $699 Pixel 5, especially because the 4a 5G had a bigger screen than the 5. Google has a lot more room to grow now that it has established the Pixel as a

The Pixel 5 lost its glass back but kept wireless charging.

midrange device.

It starts with the processor. While Qualcomm has yet to announce the successor to the 765G that powers the Pixel 4a and 5, there have been rumors that Google is working on its own processor. Axios reported earlier this year that "Google received its first working versions of the chip" and could be ready by next year. Axios reports that the chip will "include hardware optimized for Google's machine-learning technology," with part of the chip focused on "improving the performance and always-on capabilities of Google Assistant."

If Google were trying to compete with Qualcomm's speedy Snapdragon 888 I'd be skeptical. But with the Android optimizations Google already brings to its phones, a custom chip designed solely for the Pixel 6 could bring an experience akin to what Apple delivers with the iPhone. This could be just what the Pixel 6 needs to stand out in 2021.



We're already pretty sure that the Pixel 6 won't be powered by the Snapdragon 888—but it might not have a Qualcomm chip at all.

A CAMERA THAT CAN'T BE TOPPED

If there's one area where the Pixel has always excelled, it's the camera. While other phone makers have added three and four lenses to enhance the photo-taking experience, Google has done most of its work on the processing side. Things like Night Sight, Super Res Zoom, and Live HDR+ compensate for a lack of cutting-edge hardware.

The last two Pixel phones have hit something of an innovation wall. While the Pixel 5 still takes some of the best photos for a smartphone at any price, there isn't much it can do that the Pixel 4a can't also do for hundreds less. Granted, the Pixel 5 has an ultrawide lens, but the overall Pixel camera experience seems primed for a breakthrough in 2021.

Google has already proven that it doesn't need high-end specs to deliver a premium camera experience, and the Pixel 6 would be the perfect way to drive that home. Simple changes like the addition of a telephoto lens or a better sensor on the main camera would go a long way toward cementing the Pixel as the premier smartphone camera. As Google has rested on its laurels a bit,

The camera has always been the Pixel's best feature.

other phones have closed the gap with night mode and portrait mode enhancements. A jump in camera performance in 2021, especially at a lower price point, would help it reclaim the crown.

LEVERAGING THE ANDROID ADVANTAGE

Finally, there's Android itself. With timely updates, quarterly feature drops, and exclusive and "Pixel-first" features, Google has positioned the Pixel as the utmost Android experience at every price point. The relationship is only going to get tighter with Android 12.

Aside from features and optimizations, I'm expecting Google to push the Pixel's guaranteed Android updates from three to four or even five years. After Samsung upped its promise to three years in 2020, and Qualcomm announced that it will be supporting four years of updates with the 888 processor, the Pixel needs to set itself apart from the pack. Years of timely updates is one of the Pixel's strongest points. An iPhone-like level of guaranteed updates would make it the unprecedented champ.

Google's 2020 Pixel moves were definitely surprising, but I don't think it means Google is giving up on its handset as an influencer in the Android universe. Quite the opposite: With a few changes in 2021, the Pixel could finally become the phone it was always meant to be.

The Pixel 5 (left) could bring the same high-end experience that you get on an iPhone.

WHEN YOU'RE BUZZED, YOU GET IDEAS. LIKE ASKING EVERYONE INSIDE THE TACO TRUCK WHAT DRIVING AROUND IN A KITCHEN IS LIKE AND THEN ORDERING 22 TACOS WITH EXTRA GUACAMOLE AND ALL THE CHEESE FOR EVERY DRUNK PERSON IN LINE. BAD IDEA FOR YOUR WALLET, BUT NOT AS BAD AS DRIVING HOME BUZZED.

NHTSA

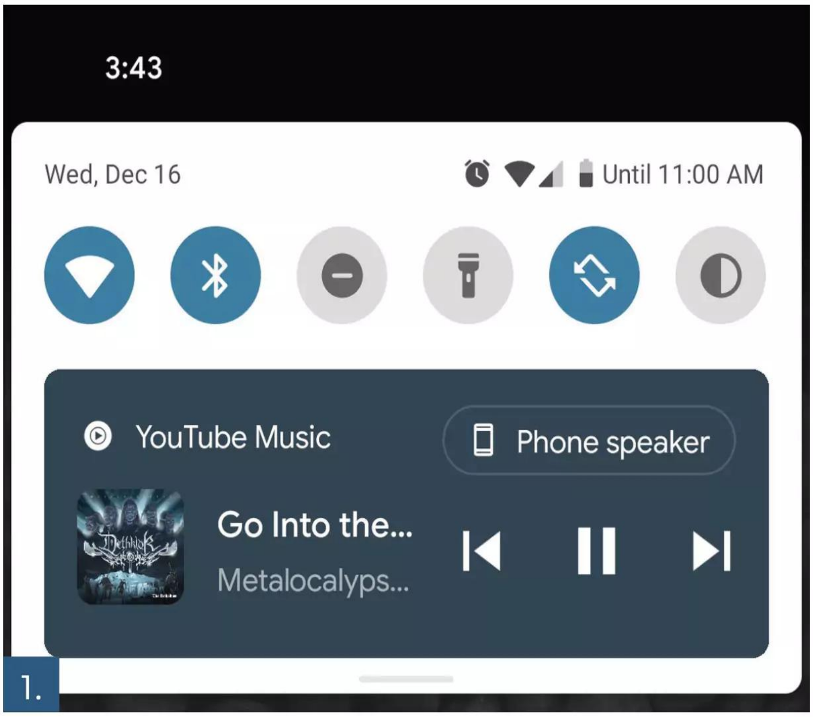
ad
COUNCIL

Android 11 tips: The 8 new features to explore first

From new playback controls to a screen recorder to dark mode scheduling, Android 11 has some improvements worth checking out. **BY RYAN WHITWAM**

There's a new version of Android floating around, and whether you get Android 11 via an OTA update or a shiny new phone upgrade, there will be new things to explore. Android 11 includes numerous quality of life improvements and security enhancements, some of which might replace features you had in the previous version. Here are eight things you should look for when acclimating to the latest OS.

IMAGE: RYAN WHITWAM


3:43
Wed, Dec 16
Until 11:00 AM
YouTube Music
Phone speaker
Go Into the...
Metalocalyps...

1.

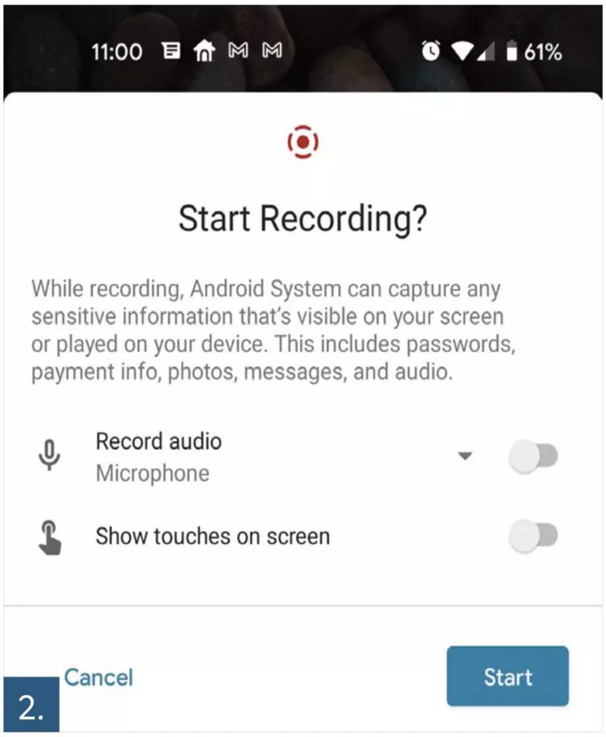
1. NEW MEDIA PLAYBACK CONTROLS

Media controls have been part of the Android notification shade for years, but that changes in Android 11. That playback notification still exists, but it'll be above your notifications in the quick settings. The upshot is your controls will always be in the same place, and they won't push important notifications out of the way. You can even swipe left and right to switch between multiple media apps. However, you do lose a row of quick settings toggles. It's probably a worthwhile trade-off.

2. SCREEN RECORDER

Believe it or not, there was a time when you couldn't take a screenshot on Android without a USB cable or root access. That changed in Android 4.0, and there may be a time when we look back on the era when we couldn't take screen recordings with equal shock. Google just added this feature in Android 11, although some OEMs like Samsung already have their own recorders. Still, this ensures virtually all phones will let you make screen recordings going forward.

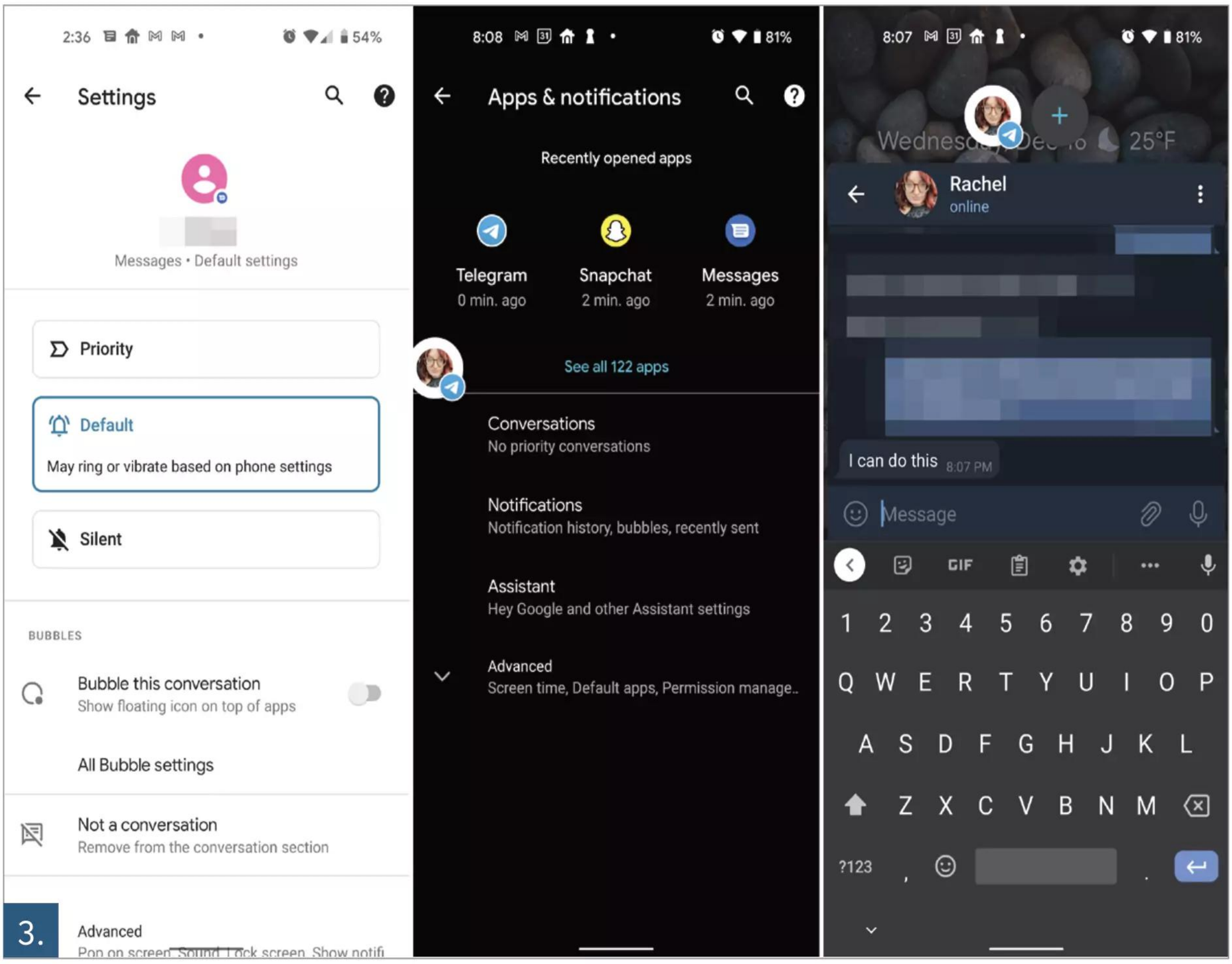
You can access this feature in the quick settings. You have the option to record audio and show touches before each recording begins. Unfortunately, you can't change the resolution or bitrate right now, so the files get pretty big. Hopefully that changes in Android 12.


11:00
61%
Start Recording?

While recording, Android System can capture any sensitive information that's visible on your screen or played on your device. This includes passwords, payment info, photos, messages, and audio.

Record audio
Microphone
Show touches on screen
Cancel
Start

2.


2:36
54%
Settings
Messages • Default settings
Priority
Default
May ring or vibrate based on phone settings
Silent
BUBBLES
Bubble this conversation
Show floating icon on top of apps
All Bubble settings
Not a conversation
Remove from the conversation section
Advanced
8:08
81%
Apps & notifications
Recently opened apps
Telegram
0 min. ago
Snapchat
2 min. ago
Messages
2 min. ago
See all 122 apps
Conversations
No priority conversations
Notifications
Notification history, bubbles, recently sent
Assistant
Hey Google and other Assistant settings
Advanced
Screen time, Default apps, Permission manage..
8:07
81%
25°F
Rachel
online
I can do this 8:07 PM
Message
GIF
1 2 3 4 5 6 7 8 9 0
Q W E R T Y U I O P
A S D F G H J K L
Z X C V B N M
?123

3.

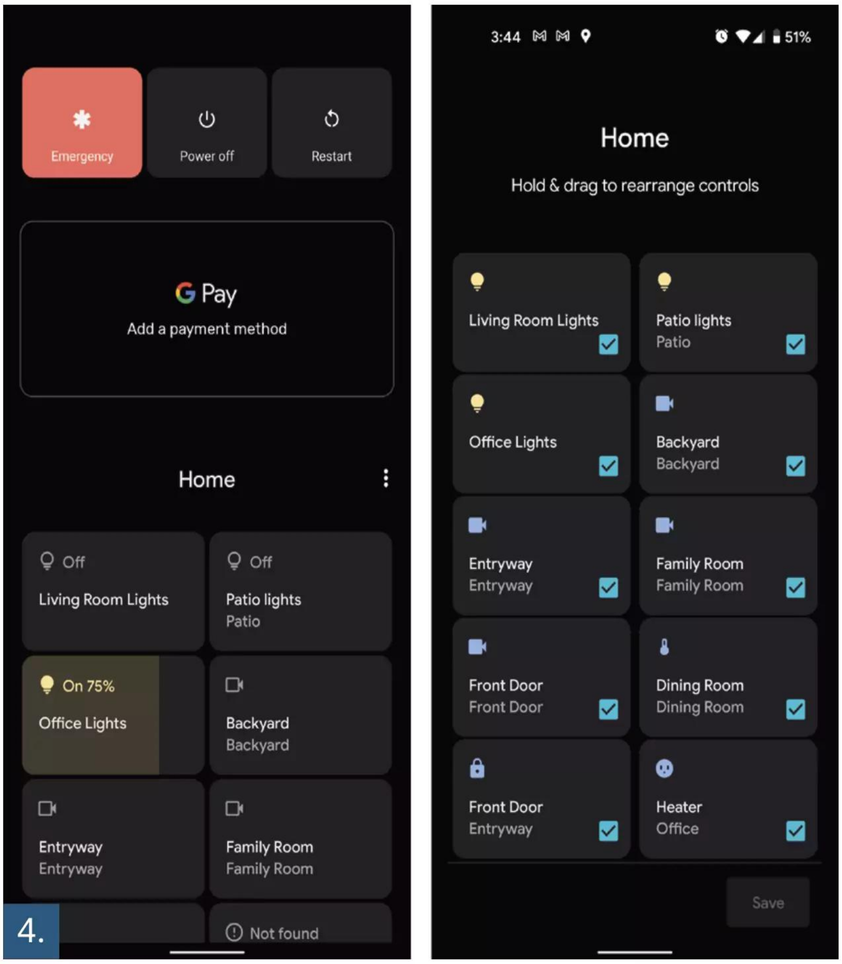
3. CONVERSATIONS AND BUBBLES

There are a couple of new ways to message in Android 11. For one, there's a new class of notifications specifically for conversations. All your apps that identify as conversations (e.g., Google Messages, Telegram, WhatsApp) will appear in a new section at the top of the notification list. You can also long-press on messaging notifications to mark the conversation as priority, so you can find them more easily in the future.

The other change to messaging is Bubbles, which allow you to turn the notifications into Chat Head-style floating icons. You can enable bubbles by tapping the notification button, or go into the notification settings for any app you want to bubble and flip the feature on.

4. POWER BUTTON MENU

The power button is for more than turning your phone off in Android 11. A long-press will bring up a screen with both Google Pay and smart home functionality. For Google Pay, just make sure you've got some cards set up in the app, and then you can switch between them on the power screen. Below


Emergency
Power off
Restart
G Pay
Add a payment method
Home
Off
Living Room Lights
Off
Patio lights
Patio
On 75%
Office Lights
Backyard
Backyard
Entryway
Entryway
Family Room
Family Room
Not found
3:44
51%
Home
Hold & drag to rearrange controls
Living Room Lights
Patio lights
Patio
Office Lights
Backyard
Backyard
Entryway
Entryway
Family Room
Family Room
Front Door
Front Door
Dining Room
Dining Room
Front Door
Entryway
Heater
Office
Save

4.

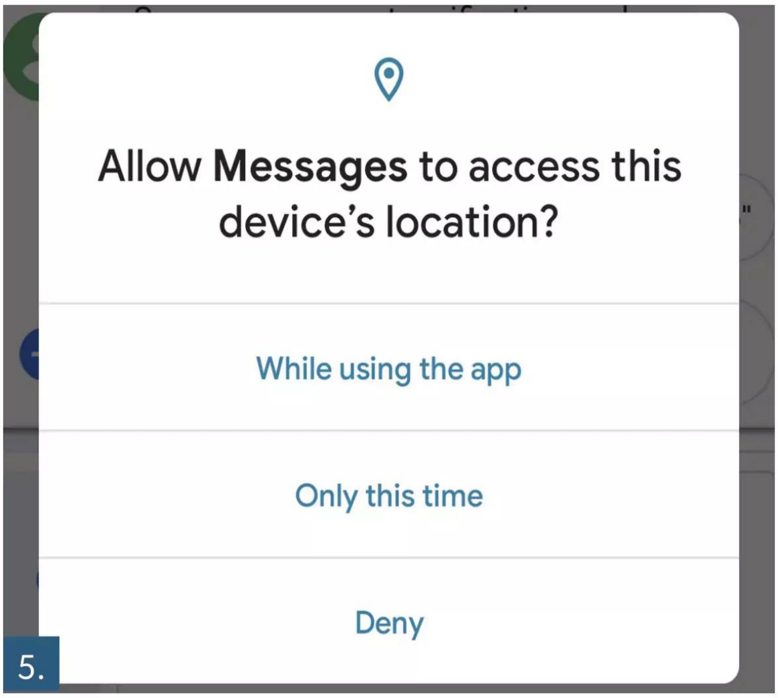
that, you've got smart home devices, which are controlled via the Home app. Android attempts to select devices you'll want access to, but you can edit them manually.

5. TEMP PERMISSIONS

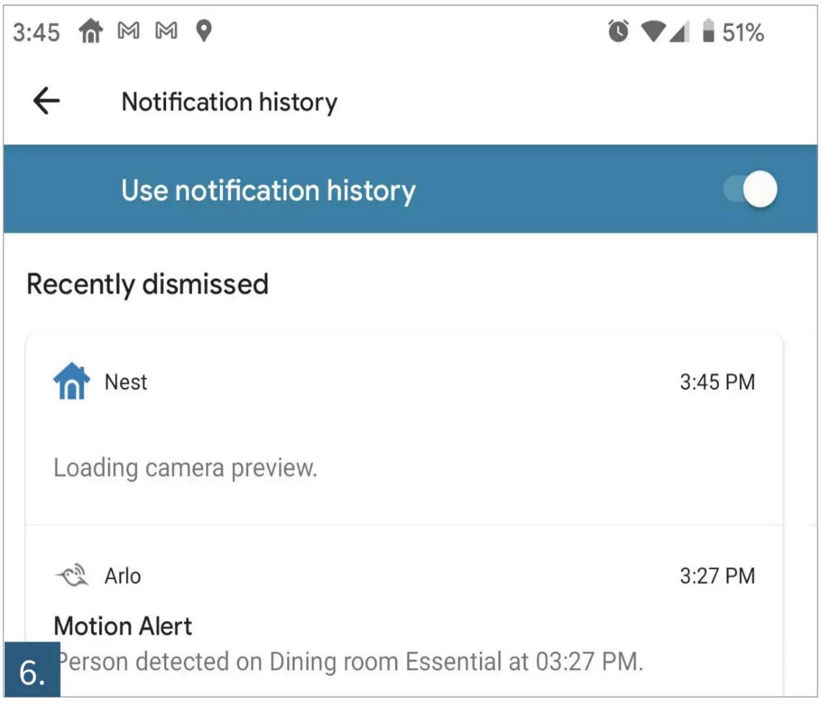
Google continues to clamp down on apps accessing your data in Android 11, perhaps most visibly with the addition of temporary permissions for microphone, camera, and location. When apps request these on Android 11, you'll have the option to deny, grant, or grant only that one time. These temporary permissions are revoked as soon as you've closed the app.

6. NOTIFICATION HISTORY

Have you ever swiped away a notification by accident? Well, that won't be a problem in Android 11, provided you change this one setting. In your notification settings, there should be a menu called


Allow Messages to access this device's location?
While using the app
Only this time
Deny

5.



3:45
51%
Notification history
Use notification history

Recently dismissed

Nest 3:45 PM

Loading camera preview.

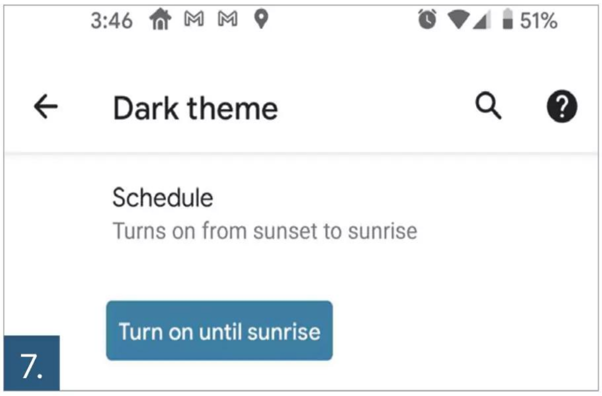
Arlo 3:27 PM

Motion Alert

Person detected on Dining room Essential at 03:27 PM.

6.

Notification History. Open it and toggle the feature on. Now you can visit that menu to see the content of any notification that arrives on your phone.



3:46
51%
Dark theme
Turn on until sunrise

Schedule

Turns on from sunset to sunrise

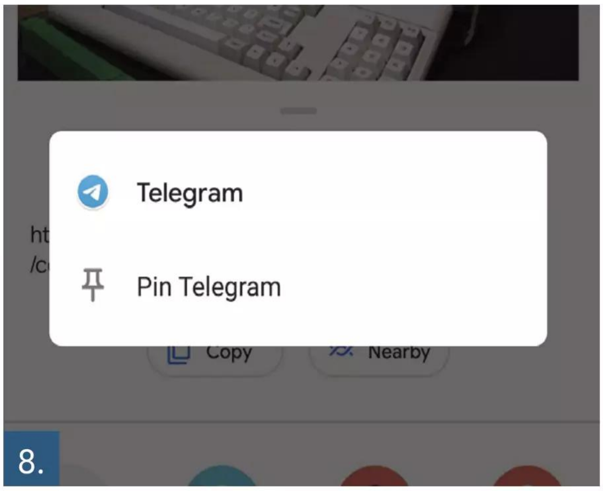
7.

7. DARK MODE SCHEDULING

After teasing us for several years, Google finally rolled out a systemwide dark theme in Android 10. But there was no scheduling option. While some phones have had that feature thanks to OEM customizations, now all phones have it in Android 11. You'll find the settings under the Display menu. It has an option for sunrise-sunset automation, or you can set a custom schedule that's more to your liking.

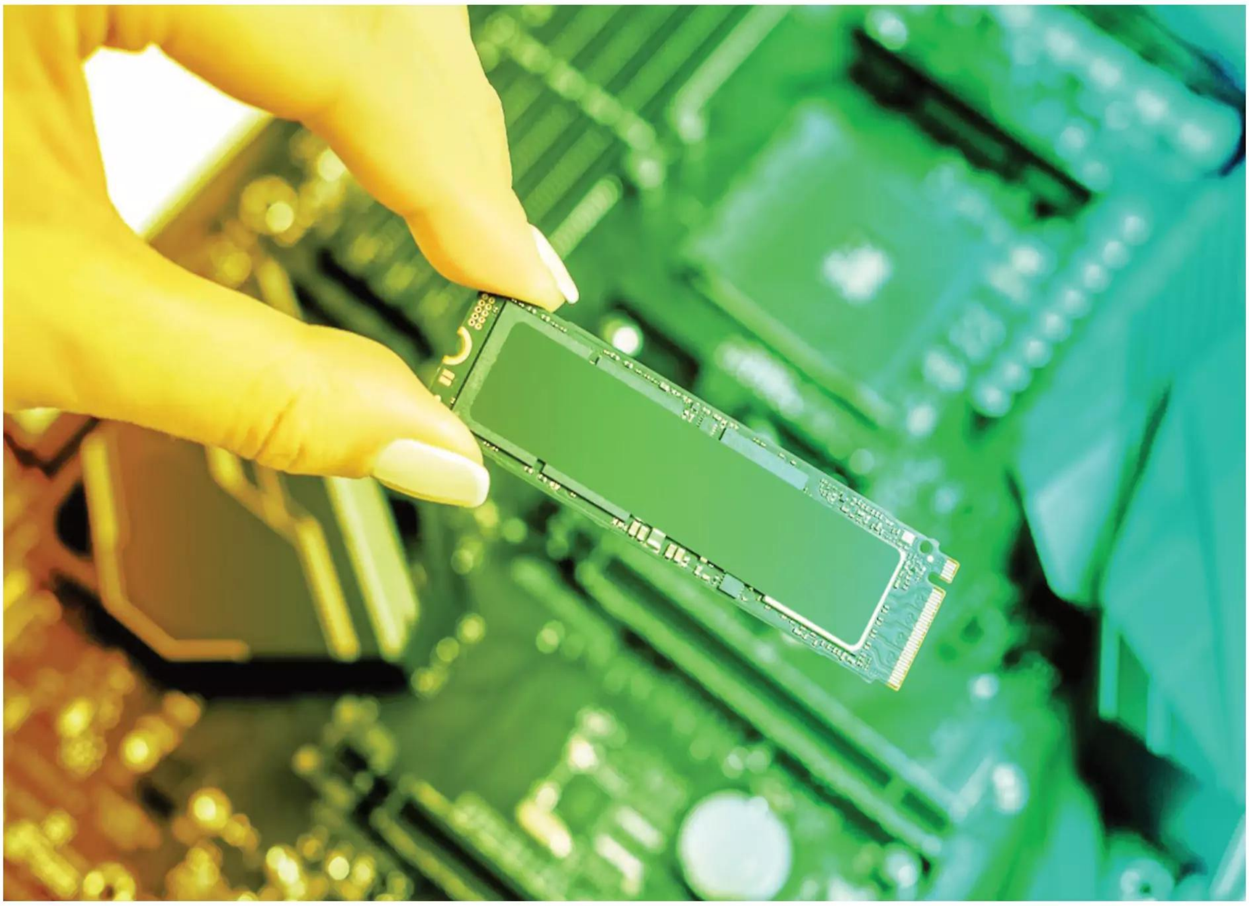
8. PIN IN SHARE

The Android share menu has been a nagging issue for the last few versions of Android. It's become so crowded, and it's hard to find apps in the list. Android 11 doesn't completely fix this, but it makes the share menu more usable by letting you pin apps to the top of your share menu by long-pressing and confirming. Now the app you want will always be right there. ⏻



Telegram
Pin Telegram
Copy
Nearby

8.



Why you may not be getting the SSD you paid for

SSD vendors may change a product during its lifespan, not always for the better.

BY JON L. JACOBI AND MELISSA RIOFRIO

The SSD you've bought may not be exactly the SSD you think it is. That's because of a common vendor practice of swapping out internal parts due to supply, pricing pressure, or other reasons.

Usually this practice has focused on the NAND flash storage modules on SSDs, and the vendor has met or exceeded the promised specification. If the change is significant, the vendors have usually changed the SKU. But as Sean Webster of Tom's Hardware discovered in his investigation of the Adata XPG 8200 Pro (go.pcworld.com/sean), the company changed the SSD controller without changing the name—except the performance changed, for the worse. There was no way of knowing the

IMAGE: GETTY IMAGES

difference from the outside.

Such practices leave both SSD buyers and we who review SSDs (go.pcworld.com/rvsd) in the dark, with no idea of whether SSD performance will be consistent throughout the life cycle of a product. So *PCWorld* reached out to the SSD vendors we cover to get more information. What we learned was mostly reassuring, but unfortunately the onus remains upon the buyer to figure out what you're getting.

CHANGE IS GOOD, MOST OF THE TIME

There are legitimate reasons for changing an SSD, most either benign or positive: bug fixes, firmware updates, faster components. No harm, no foul, though we'd also like a new revision number if changes are significant.

Supply issues may also lead to component changes, especially with smaller vendors who are picking parts off the shelf, as it were. Again, no harm, no foul.

However, one of the three Adata XPG8200 Pro NVMe SSDs Tom's Hardware looked at was about 300MBps slower than the others. Foul.

According to one industry source who asked not to be named, Adata is not alone: Dataram, Kingspec, and Avant were also mentioned as having changed to inferior components at one point or another.

We're not accusing any vendor of truly malevolent behavior. Stuff happens. But let's just say the behavior is bad for users in the short term, and bad for the company's reputation in the long run.

A WORD FROM THE VENDORS

PCWorld contacted all the SSD vendors mentioned in the Tom's Hardware story, as well as others mentioned by our source, and any other major players, asking for more information about component stability and transparency in labeling.

Alas, there was no hard comment from

V-NAND SSD
970 EVO Plus
NVMe M.2
www.samsung.com/ssd
SAMSUNG ELECTRONICS CO., LTD.
2TB
SAMSUNG

Samsung's 970 EVO Plus is the right way to go about things. Significant change, change the name. This came in handy when incompatibilities with Macs ensued.

Adata forthcoming in time for this article. But to their infinite credit, several vendors were more than willing to chime in, including Silicon Power. The company admitted to changing components, but promised that the product would still meet performance claims. Apacer said the same about its pro and consumer lines, but said there would be no component changes in the company's industrial line.

Fledging and OWC both said they alter model numbers and SKUs to reflect any changes. Sabrent and SK Hynix flat-out said they retain the same components. Assuming those company's suppliers don't fiddle about, that's ideal. Note that SK Hynix is its own supplier, which makes it a lot easier.

Seagate said its products are "designed to meet their stated performance requirements." Other larger vendors were less willing to engage. Responses varied from no-comment from Samsung and Kingston, to no response at all from WD/Sandisk. Crucial acknowledged receipt of my email but had not responded further by the time of this writing.

We've reviewed products from all these vendors and never experienced nor heard about their SSDs' failing to perform as advertised. WD caught some flack recently (go.pcworld.com/flak) over mislabeled SMR HDDs, however, and Kingston is mentioned in the Tom's Hardware article as having had an issue well in the past.

AS ALWAYS, CAVEAT EMPTOR

Vendors: We understand you might need to change components. All we're asking is that you slap a revision number on it and make sure people can see it.

Users: If the drive you buy doesn't seem to measure up, it may be because of a component change. And though it saddens me to say it, treat the performance results you find in our SSD reviews (go.pcworld.com/rvsd) as a moment in time. We unfortunately can't guarantee that the drive you buy will be exactly the same as the one we reviewed. We hope it's as-good or better.

Western Digital
WD RED™
3.5" NAS HARD DRIVE
Western Digital
WD RED™
2.5" NAS HARD DRIVE

WD took some flack over mislabeled SMR HDDs.

SK hynix
SOLID STATE
DRIVE

How to find out if your laptop can take an SSD

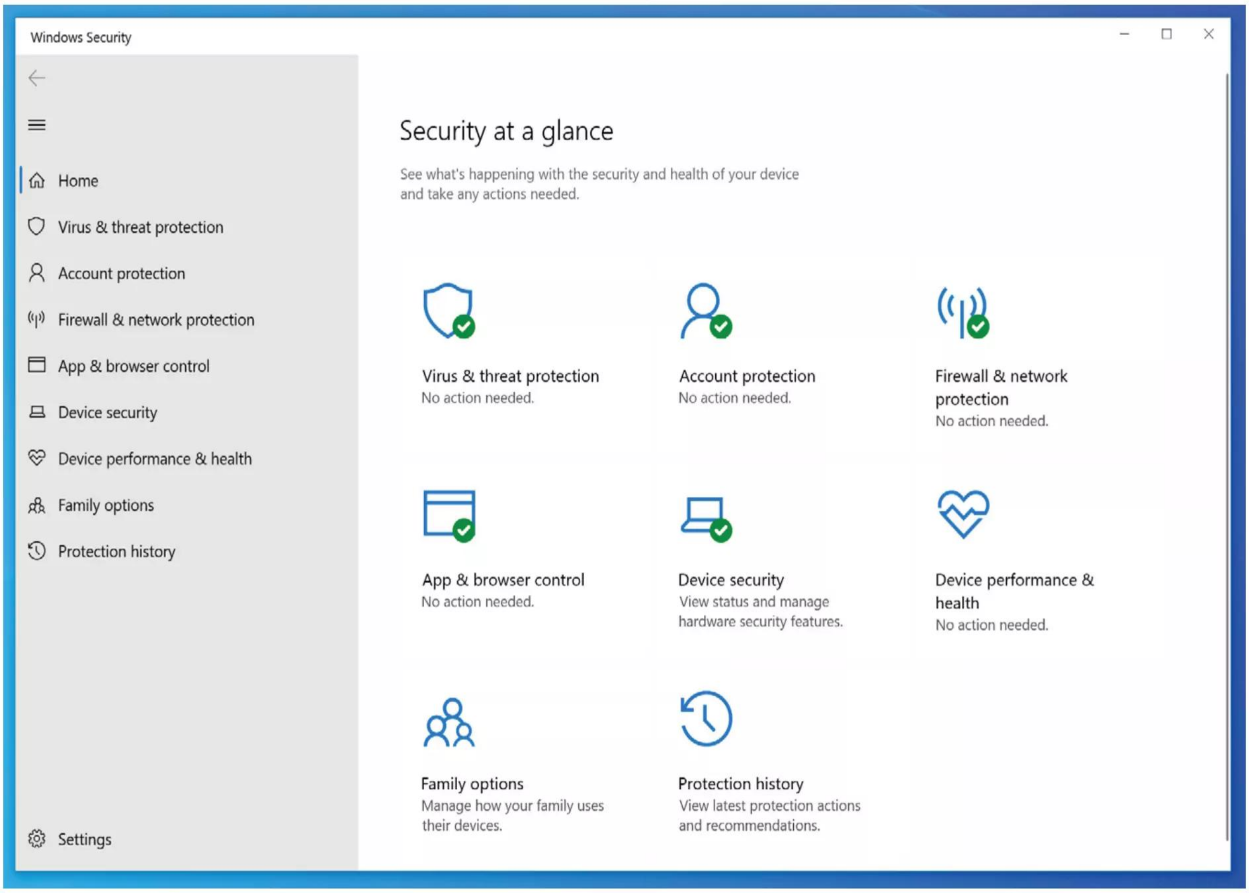
Give your old laptop a big performance boost. **BY GORDON MAH UNG**

Give your old laptop a big performance boost with one simple upgrade: replacing its traditional, spinning-platter hard drive (HDD) with a chip-based solid state drive (SSD). SSDs are becoming more affordable, and they are magnitudes faster than a hard drive in reading and writing data.

There's just one question: Can your laptop even take an SSD? If you're not sure, we'll help you figure it out in this video.

VIDEO: **HOW TO FIND OUT IF YOUR LAPTOP CAN TAKE AN SSD**
Watch now at go.pcworld.com/lsd

IMAGE: IDG



Windows Security

- Home
- Virus & threat protection
- Account protection
- Firewall & network protection
- App & browser control
- Device security
- Device performance & health
- Family options
- Protection history
- Settings

Security at a glance

See what's happening with the security and health of your device and take any actions needed.

Virus & threat protection
No action needed.

Account protection
No action needed.

Firewall & network protection
No action needed.

App & browser control
No action needed.

Device security
View status and manage hardware security features.

Device performance & health
No action needed.

Family options
Manage how your family uses their devices.

Protection history
View latest protection actions and recommendations.

What you need to know about Windows Security in Windows 10

From the firewall to antimalware to ransomware protections: here's an overview of what's inside of Windows 10's Windows Security. **BY MARK HACHMAN**

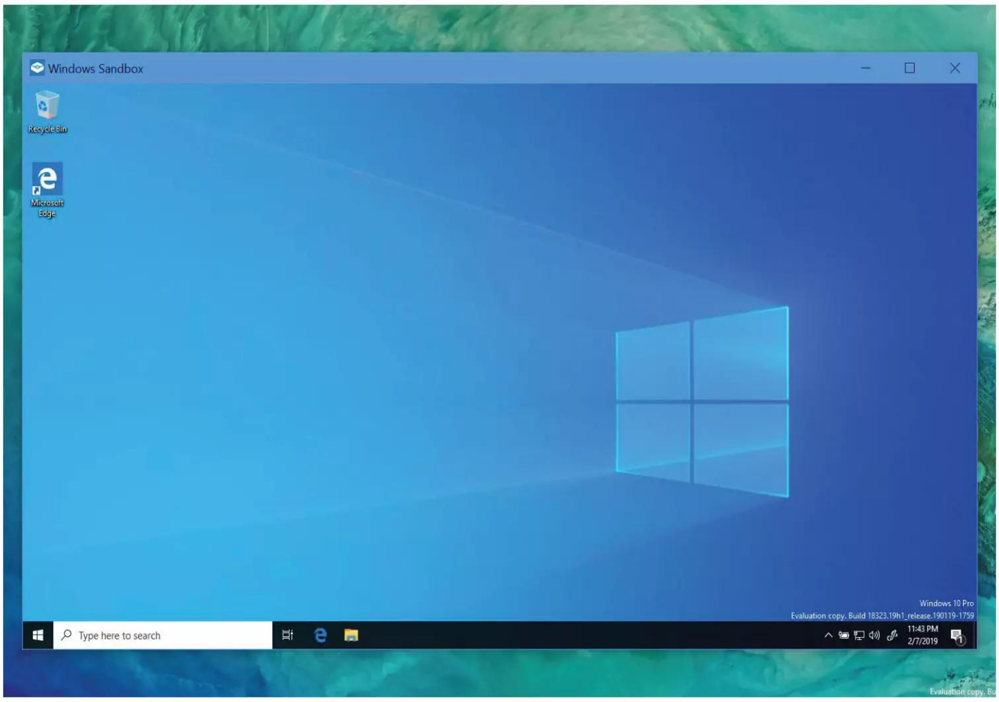
Microsoft's Windows Security acts like an airbag: It will protect you, regardless of whether you know it exists. You'll find a number of technologies grouped within the Windows 10 Settings menu, all designed to secure your PC from malware.

Our video walks through the basic components of Windows Security, from the antimalware technologies built into Windows Defender all the way up through the browser security features associated with Microsoft Edge. We show you what each feature does,

VIDEO: **HOW TO USE WINDOWS SECURITY IN WINDOWS 10**

Watch now at go.pcworld.com/wsc

IMAGE: MARK HACHMAN

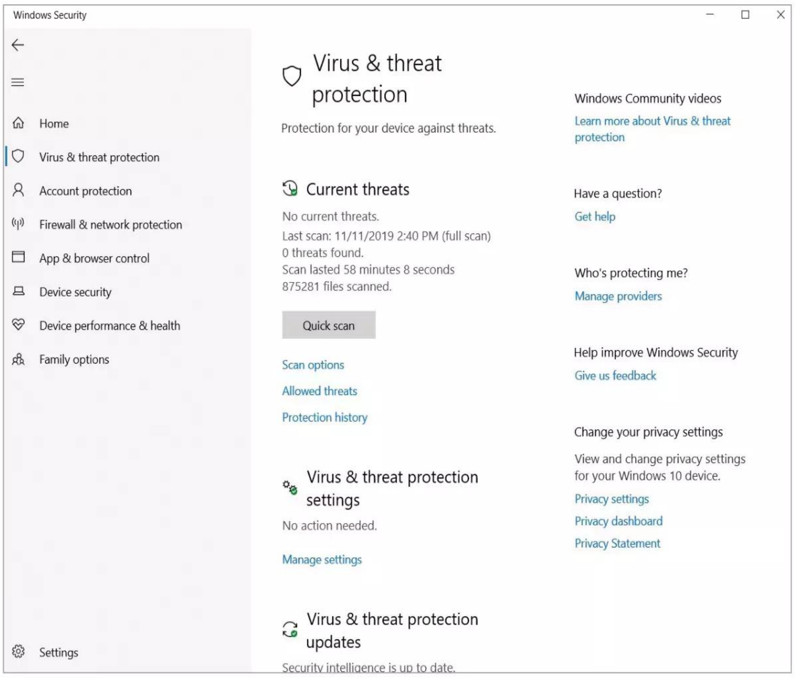

Windows Sandbox
Recycle Bin
Microsoft Edge
Type here to search
Windows 10 Pro
Evaluation copy. Build 18323.19h1_release.190119-1759
11:43 PM
2/7/2019

Windows Sandbox, in a window, looks like Windows—because it is. It's just another Windows desktop firewalled from your primary installation.

and if there are any changes you'll need to make to better secure your PC.

You'll learn about how Windows tries to protect your PC: preventing malware from getting on your PC in the first place, blocking pernicious attacks like rootkits, and walling off your documents to prevent them from being infected. (Want even more protection? Learn how to use Windows Sandbox, too (go.pcworld.com/wsbx)!

After you learn what each setting does, check out our more formal review of Windows Security (go.pcworld.com/wsec), which examines how its settings can impact your PC's performance. In a separate story, we argue that Windows Defender is good enough (go.pcworld.com/wndf) that you can consider opting out of paid antivirus solutions—if antimalware is all you're concerned about, at least.


Windows Security
Home
Virus & threat protection
Account protection
Firewall & network protection
App & browser control
Device security
Device performance & health
Family options
Settings

Virus & threat protection

Protection for your device against threats.

Current threats

No current threats.
Last scan: 11/11/2019 2:40 PM (full scan)
0 threats found.
Scan lasted 58 minutes 8 seconds
875281 files scanned.

Quick scan

Scan options
Allowed threats
Protection history

Virus & threat protection settings

No action needed.

Manage settings

Virus & threat protection updates

Security intelligence is up to date.

Windows Community videos
Learn more about Virus & threat protection

Have a question?
Get help

Who's protecting me?
Manage providers

Help improve Windows Security
Give us feedback

Change your privacy settings

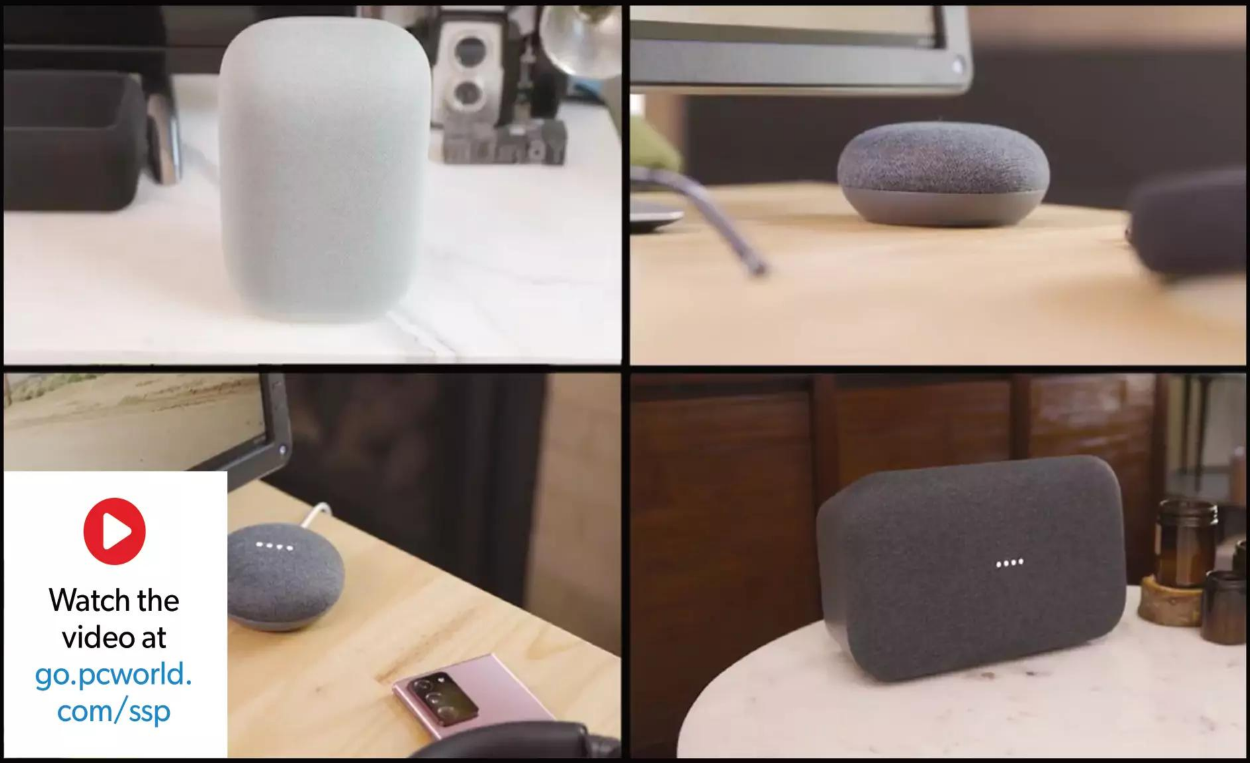
View and change privacy settings for your Windows 10 device.

Privacy settings
Privacy dashboard
Privacy Statement

Windows Security's virus scan section.

Tech Spotlight

A video showcase
of the latest trends



Watch the video at go.pcworld.com/ssp

Best smart speakers for the price

So, you've settled on a price range for your first—or latest—smart speaker and you're ready to go shopping. Which smart speakers are the best values in today's market? We have a few picks to match your budget.